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Photographs of the Lunar Eclipse of March 22, 1932

By ALBERT W. RECHT

It has been my desire to have a series of photographs of a lunar eclipse similar to some of those taken of solar eclipses. Consequently, despite the somewhat unfavorable conditions of observing the recent nearly total eclipse from Denver, I made arrangements to take the series. The Chamberlin refractor, of 20-inch aperture and 320-inch focal length, has only recently been adapted for photographic work. Although the lens was designed so that the crown glass could be reversed and thus the telescope could be converted into a photographic refractor, that has been done only once—at the total eclipse of 1918.

For these photographs the lens was not reversed. A minus-blue gelatin filter and panchromatic plates were used. The exposures ranged from one second for the first of the series to six seconds for the sixth. They were taken at 3:47, 3:58, 4:13, 4:28, 4:43, and 4:58, Denver time, which is 7 hours earlier than Greenwich time. The first picture shows the effect of the penumbra. The second photograph was made at the time of first contact of the umbra. The maximum eclipse occurred at 5:32. A plate exposed for 12 seconds at 5:12 showed nothing. From then until 5:35 the moon was clouded, a fact which made some Denverites believe the eclipse was total. A plate exposed at 5:38 for one minute showed practically the whole disc of the moon, with the lower limb much over-exposed. (Plate V.)

These photographs would have shown the edge of the shadow more plainly if they had been over-exposed. But such over-exposure would have cut out the details of the moon's surface and destroyed the value of the photographs for my purpose. For the same reason the prints were not "doctored" by vignetting. They are contact prints on semi-contrast bromide paper. Because the altitude of the moon was less than 30°, even for the first of the series, the definition of its surface is not very good. But the series will make an excellent class demonstration.

CHAMBERLIN OBSERVATORY, DENVER, COLORADO.

The Elgar Weaver Observatory of Wittenberg College

By HUGH G. HARP

The Elgar Weaver Observatory of Wittenberg College was erected through the generosity of Mr. and Mrs. Elgar Weaver of Brookville, Ohio. Several years ago Mr. and Mrs. Weaver made an initial gift of $6,000 for the purchase of a telescope, and later a gift of $20,000 for a suitable building. Then in June, 1929, after further consideration, they graciously decided to increase these previous gifts to the sum of $50,000 which was to be used in the erection and equipment of an astronomical observatory. During the remaining months of this year building plans were prepared by the architects, Eastman and Budke of Springfield, Ohio, in collaboration with Sellew and Towner of Middletown, Connecticut. The general building contract was made with the James I. Barnes Company of Springfield, Ohio. On March 31, 1930, ground was broken and actual construction was begun. By February 1, 1931, the Observatory was completed and ready for use. The total cost of the project, the building and equipment, is approximately $80,000.

On June 3, 1931, in the presence of a large assembly of friends and visitors and with appropriate ceremonies, the Elgar Weaver Observatory was dedicated. Mr. and Mrs. Weaver were present and received a splendid ovation. The dedicatory address was made by Professor Heber D. Curtis, Director of the Observatory of the University of Michigan.

The Observatory is located on the western edge of Wittenberg's fifty-acre campus, which lies in the northwest quadrant of the city of Springfield. To the west and northwest the surrounding country is mostly wooded. The prevailing winds are westerly. These factors make the location as suitable as could be found within the city limits. Heat is supplied by a central heating plant situated about 1000 feet to the northeast.

The building fronts east and is set approximately due north and south. Preliminary determinations give the terrestrial coördinates as latitude 39° 56′ 8″ north and longitude 83° 48′ 57″ west. The elevation above sea level is 1000 feet.

In style of architecture the building is collegiate Gothic. This is in harmony with other buildings on the campus. The exterior walls are built of several shades of red brick which are laid in a simple diaper pattern design and are trimmed with Indiana limestone. Reënforced concrete and steel form the internal structure. The general plan of the building is rectangular. The hemispherical dome is centered in the rectangular flat roof which is surrounded with a 5-foot parapet wall capped with ornamental stone. Structural beauty and astronomical usefulness are foremost in the plan.

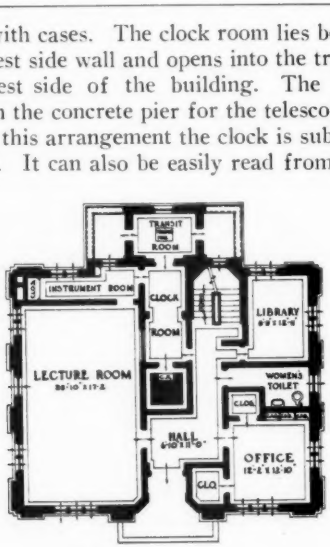
The dominant architectural feature of the front of the building is the deeply recessed arched entrance. Above this is a panel in which are displayed in an ornamental manner twelve figures representing the zodiac. The panel is framed on each side by two pilasters which terminate in octagonal finials above the parapet and on which are cut in ornamental letters the names of sixteen great astronomers: Hipparchus, Ptolemy, Copernicus, Galileo, Tycho Brahe, Kepler, Newton, Römer, Cassini, Rittenhouse, Herschel, Laplace, Fraunhofer, Newcomb, Pickering, Kapteyn. These features contribute an astronomical atmosphere to the building.

FIGURE 1.
THE ELGAR WEAVER OBSERVATORY.

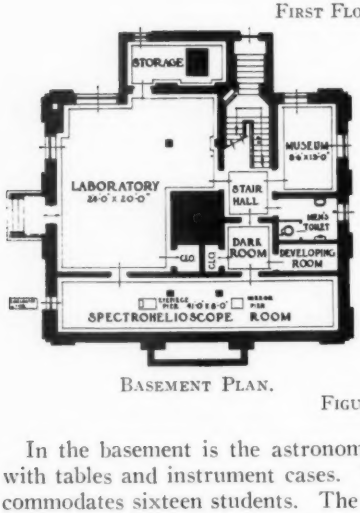
The main building is 44 feet across the front and 35 feet deep. It contains three floors; the main floor, the basement, and the second floor. In the center of the building and structurally independent, from the base to the top, is the massive concrete pier which supports the telescope at the second floor level. The lowest part of this pier is fourteen feet below the basement level. It is nine feet square at the bottom and at the basement level and tapers to a top of four by three feet at the second floor level. It is entirely enclosed by walls which also form the interior partitions of the building.

The main floor contains a lecture room, an office, a clock room, a transit room, a library, and a small instrument room adjoining the lecture

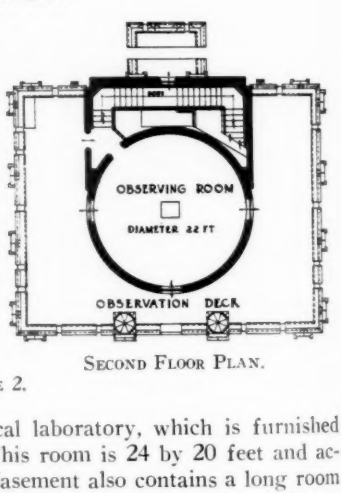
room and provided with cases. The clock room lies between the central pier space and the west side wall and opens into the transit room, which projects from the west side of the building. The sidereal clock is mounted in a niche in the concrete pier for the telescope and is enclosed by a glass door. By this arrangement the clock is subject to only slight temperature changes. It can also be easily read from the transit room.



First Floor Plan.



Basement Plan.



Second Floor Plan.

Figure 2.

In the basement is the astronomical laboratory, which is furnished with tables and instrument cases. This room is 24 by 20 feet and accommodates sixteen students. The basement also contains a long room for a spectrohelioscope, a dark room, and a small room to be used as a display room for models and transparencies.

The second floor is so arranged as to provide an indoor housing for the telescope and an outdoor elevation for observing the whole sky.

The indoor portion of the second floor is a circular room, 22 feet in diameter, and is centered over the concrete pier which supports the tele-

scope. This room is enclosed by a thick wall of reënforced concrete, which supports the revolving dome. The dome is hemispherical and consists of a steel framework which is covered with wood sheathing, carrying the outer covering of 16-gauge copper sheeting. The aperture is four feet wide and permits the telescope to operate from the horizon to the zenith. This is closed by a single shutter, which is operated sidewise by a hand wheel. The motive power for turning the dome is a five-horsepower motor, which is controlled by switches placed in the pier of the telescope. The dome was constructed and erected by the Berlin Construction Company of Berlin, Connecticut, under the supervision of Sellew and Towner of Middletown, Connecticut.

The outdoor portion of the second floor forms the roof of the lower floor and also serves as an observation deck. This is covered with 4-inch tile and has a gentle slope for drainage purposes. This space extends around the circular observing room, except that required for the stairway, and is enclosed by a parapet. This outdoor elevation or deck roof is readily accessible, and forms a convenient place in which to use portable or small instruments and to study the constellations. From the standpoint of the practical need of the students, this is a most desirable feature of the building.

The major equipment of the Observatory includes the 10-inch refracting telescope designed and built by Sellew and Towner in collaboration with C. A. Robert Lundin, who made the objective; a combined 3-inch transit and zenith telescope designed by Gaertner; a chronograph also designed by Gaertner; sidereal and mean time clocks made by Howard.

The minor equipment includes a Longines chronometer, a Gaertner micrometer, a sextant, a 3-inch portable refracting telescope, several laboratory spectroscopes, celestial globes, models, etc.

The telescope is a 10-inch visual refractor with a focal length of 150 inches. The mounting is the usual Fraunhofer type. The driving mechanism is actuated by a small motor, which is controlled by a rotating governor. The circles are extra large and are equipped with verniers which read to six minutes in declination and to one minute of time in right ascension. The telescope tube is made of duralumin and is attached off center slightly nearer the eye end in order to save operating space.

Incorporated in the cast iron pier of the mounting is a quick setting mechanism. The exterior parts of this device consist of a hand wheel and a dial which are placed on the north side of the pier at eye level. The wheel is mechanically connected with the polar axis of the telescope and is used to change the telescope quickly from one side of the pier to the other or to set the telescope at any required hour angle or right ascension. The dial is composed of two parts: an outer ring fixed to the pier and an inner disk rotated by clockwork. The outer ring is graduated into 24 main divisions, and these main divisions into 6 subdivisions. The

main divisions are numbered from 0 to 23. The 0 is placed at the top of the dial, and the numbers then increase in a clockwise (positive) direction as the operator faces the dial. The inner disk is similarly graduat-

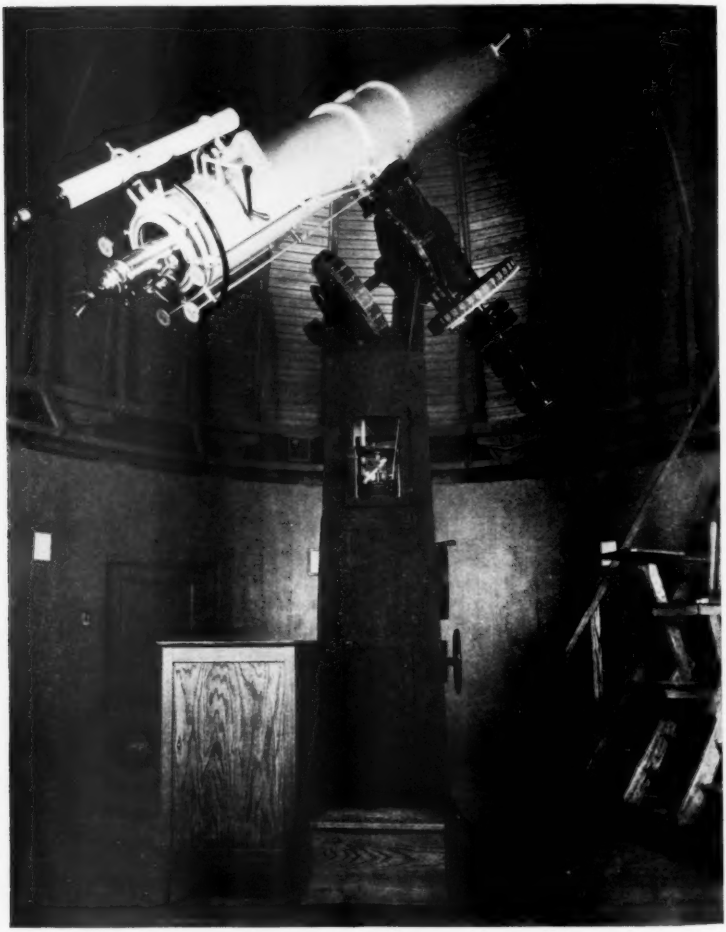


FIGURE 3.
THE 10-INCH REFRACTOR OF THE ELGAR WEAVER OBSERVATORY.

ed and numbered from 0 to 23, but in the opposite direction. The inner disk is attached to a sleeve, which is turned by a telechron clock through a special gearing in order to turn the disk at the sidereal rate. The disk then functions as a sidereal clock with a very slight error. Through

the sleeve in the center of the dial is a shaft, which is mechanically connected with the hand wheel. On this shaft is a pointer so adjusted as to follow the direction of the telescope as it moves about the polar axis. The pointer then indicates the hour angle on the graduations of the outer ring of the dial. The graduations on the disk are numbered anticlockwise, but the disk is turned in the opposite direction. This rotation of the disk simulates the motion of the celestial sphere as the operator faces south. The reading of the disk at the zero point on the ring at the top of the dial is the right ascension of the meridian, or the sidereal time. The position of the pointer on the disk indicates the right ascension of the point in the sky which is in the center of the field of the telescope.

This combined setting mechanism and sidereal clock is a useful accessory to any telescope. Since the disk is entirely independent of the driving clock, it operates continuously on the electrical outlet and thus provides sidereal time on the pier of the telescope at any time. Convenience in setting the telescope is obvious. To direct the telescope on any object whose right ascension is given, one has merely to turn the hand wheel until the pointer comes to the corresponding time on the inner disk or sidereal dial. The dial is twelve inches in diameter, and large enough so that reading or settings can be made to an accuracy well within a minute of time. The simple relation between sidereal time, right ascension, and hour angle is easily demonstrated with this device.

The Elgar Weaver Observatory was designed primarily for educational purposes. The arrangement of space in the building and the selection of the equipment are the result of careful consideration of modern demands of collegiate instruction in astronomy. The first year of the new Observatory on the campus of Wittenberg College has just ended. Surely student interest in astronomy is growing. In the semester that has just closed the department offered two courses in astronomy, in which were enrolled a total of forty-five students.

An important addition to the instructional program is the course in laboratory astronomy. This course meets the graduation requirement of eight semester hours in a laboratory science. Three hours per week are spent in this laboratory work, which includes a variety of indoor exercises and experiments in addition to observing with the 10-inch refractor.

The equipment of the Observatory is of the highest type. In addition to their instructional uses, the facilities are suitable for the undertaking of a modest research program as the time of the director permits. In the past year much time has been devoted to the setting and adjusting of the telescope and the transit, the rating of the clocks, and the determination of constants.

The Elgar Weaver Observatory now takes its place among the many observatories of American colleges. Its task is to contribute to the ex-

position and the expansion of the most ancient, the most inclusive, and the most modern of all the sciences, astronomy.

SPRINGFIELD, OHIO, FEBRUARY 27, 1932.

The Motions of Long-Period Variable Stars

By PAUL W. MERRILL

(Fifth Paper)*

The study of the motions of the stars is a difficult but fascinating branch of astronomy. Our knowledge of stellar motions, particularly of those of variable stars, is at present very incomplete, but many facts, some of them quite puzzling, have been brought to light. Statistical methods must be employed in most investigations because the observed motions of individual objects usually do not find immediate interpretation; and these methods require extensive data, the accumulation of which is slow and laborious.

To the naked eye, or even through a powerful telescope, the stars appear to be relatively fixed, as if fastened in a rigid but invisible matrix. As a matter of fact, nearly all the stars move at speeds of many miles, not per minute, but *per second*,—hundreds of times as fast as the fastest train and dozens of times as fast as a cannon ball. Yet hurtling through space with these tremendous speeds, they get nowhere; the universe is too big. Here again, as in other properties of the stars, we encounter the bewildering contrast between the apparent and the real.

To ancient observers the stars seemed immobile, and were called "fixed" to distinguish them from planets or wandering objects. For centuries neither the motions of individual stars nor the heroic migrations of great groups of stars evoked the notice of terrestrial observers. Finally, early in the eighteenth century, Halley recognized that a few bright stars must have moved since Ptolemy's time. Later, by a process akin to "setting stakes," numbers of stars were caught in the act of changing their positions, and thus began the study of stellar motions.

Since Halley's discovery, more than two centuries ago, a vast amount of human energy has been devoted to determinations of stellar motions, and the data which astronomers have now accumulated are astonishingly extensive. In spite of this, however, but little progress has been made toward a general interpretation of the motions.[1] We know but little of the general system (if such there be) which includes the motions of var-

*For preceding papers, see February, May, and October (1929), and March (1931) issues.

[1] This statement, of course, together with all others in this article, refers only to the so-called fixed stars and not at all to planets. Taking for granted the law of gravitation, we now understand in almost complete detail the observed motions relative to the sun of the bodies within the solar system.

ious individual objects, and we are in dense ignorance concerning the origin of the motions. The subject is, of course, inherently difficult. The stars are so far apart that it is difficult to understand how their motions are inter-related; yet on the other hand it is incredible that each star should be a little closed kingdom moving by itself without any relationship, past or present, to any other star. Statistical facts concerning stellar motions have been brought to light by many investigators among whom may be mentioned Herschel, Kapteyn, Campbell, Schwarzschild, Eddington, and Seares, but most of these facts seem to lack complete generality,—they are but parts of the whole picture. During the past few years, through the efforts of Strömberg, Linblad, Oort, Wilson, Plaskett, and others, a rotation of the galaxy has been dimly outlined; and a bewildering apparent expansion of the more remote portions of the universe has been revealed by the observations of Slipher, Humason, and Hubble.

The observed motions of long-period variable stars, because they cannot now be explained, make painfully evident the incompleteness of our knowledge of the system of the stars. The high speeds clearly evidenced by spectroscopic observations are an obstacle to the once popular Lockyer-Russell theory of stellar evolution, which has no suggestion to account for them. The emphasis to be placed upon the inadequacy of the theory in this respect will vary with individual temperament, but all will agree that the last word on the general course of stellar evolution has not yet been written. Strömberg's treatment of stellar velocities provides an orderly place for the high motions but does not offer a convincing physical explanation of their existence. These matters are mentioned here to show that long-period variables have interesting relationships to several very general stellar problems.

The motion of a star through space will, in general, cause a change both in its distance from us and in its apparent direction. It will therefore be convenient to consider the motion resolved into two components, one (called "radial" motion) lying in the line joining the star to the earth, the other ("proper" motion) comprising all motion at right angles to this line. We consider first proper motion.

The observed proper[2] motion of a star is its angular displacement relative to other stars, as seen from the earth. The motion is often considered to take place on the surface of the "celestial sphere," a hypothetical sphere of arbitrary radius whose center coincides with the observer. Proper motions may be determined from precise meridian circle observations at two or more epochs, preferably many years apart; or proper motions may be derived from photographs on which the positions of stars comparatively near us are measured with respect to distant "background" stars whose displacements, either individually or in

[2] The word *proper* refers in this connection to a star's own relative motion as distinguished from those systematic apparent changes in direction, such as precession or aberration, caused by motions of the earth.

the mean, are negligible. The observed change in position may arise from the motion either of the star itself or of the solar system with respect to the reference stars.

Proper motions as measured are angular displacements and are usually in seconds of arc per year. A star's linear speed in miles or kilometers per second, corresponding to a given proper motion, can be computed only if the star's distance is known. Unfortunately the distances of individual long-period variables are not accurately known. Another limitation of the proper motion data lies in the fact that many of the observed displacements are scarcely larger than errors of measurement, and in these instances no reliance can be placed on the results for individual stars. Statistical conclusions of value may be obtained, however, provided the methods of combining the data are such as to eliminate or reduce the effects of errors of measurement.

Extensive lists of proper motions of long-period variables have been published by W. Gyllenberg[3] and by R. E. Wilson.[4] Wilson's results for a number of the better known variables are given in Table I. The proper motions in general are small, but few exceeding 0".1 per year, a fact that suggests at once that the variables are probably relatively distant and therefore of high intrinsic brighness. Our first guess is accordingly that these objects are giant stars rather than dwarfs, and this tentative conclusion is confirmed by fuller investigation.

TABLE I.

PROPER MOTIONS AND RADIAL VELOCITIES OF LONG-PERIOD VARIABLES.

Star	Desig.	Spectrum	Proper motion per year	Radial Velocity km/sec
T Cas	001755	M8e	0".040	—11.0
R And	001838	Se	.026	— 8.2
o Cet	021403	M6e	.229	+64.5
R Aur	050953	M7e	.053	(+ 8.)
R Lyn	065355	Se	.076	(+34.)
R Gem	070122	Se	.008	—36.
R Leo	094211	M8e	.042	+15.0
R Hya	132422	M8e	.065	— 5.0
χ Cyg	194632	M6pe	.093	— 0.5
T Cep	210868	M7e	.057	—10.7
R Aqr	233815	M7e + Pec	.029	—19.
R Cas	235350	M7e	.071	+30.

It is very fortunate that the spectroscope is able to measure the component of a star's total motion which does not enter into its proper motion, namely that which lies along the direction to the star, or in the "line of sight." Moreover, since the spectroscopic measurements give with considerable accuracy the actual linear motion in kilometers per second, some of the uncertainties inherent in the use of proper motions

[3] *Meddelanden fran Lunds astronomiska Observatorium*, Ser. II, Nr. 27, 1922; *Ibid*, No. 53, 1929.

[4] *Astronomical Journal*, **34**, 23, 1922; *Ibid*, **34**, 183, 1923; *Ibid*, **35**, 125, 1923.

are avoided. The motions in the line of sight, measured by the spectrograph, are called radial velocities. We now turn to a consideration of these data.

The determination of stellar radial velocities rests upon the famous Doppler-Fizeau principle, which states that all the lines in the spectrum of an approaching source of light have their wave-lengths shortened by an amount which bears the same ratio to the normal wave-length that the velocity of the source (relative to the observer) bears to the velocity of light; and the lines of a receding source have their wave-lengths lengthened by like amounts. Algebraically

$$\Delta\lambda/\lambda = V/C$$

where λ = normal wave-length.
$\Delta\lambda$ = change in wave-length.
V = velocity of source.
C = velocity of light.

The velocity of light is 300,000 kilometers per second, while 30 km/sec would be a typical stellar velocity. According to the equation given above, the corresponding shift in wave-length would be 30/300,000 or 1/10,000 of the wave-length itself. The lines usually employed in velocity determinations are in the violet with wave-lengths of, say, 0.0004 millimeter. The change in wave-length caused by the star's motion is therefore about 0.00000004 millimeter. To measure so minute a quantity in a feeble beam of star-light would seem a difficult undertaking. It is possible only because the spectrograph, in effect, multiplies the wave-length displacements by a very large factor. Even in a small single-prism spectrograph, such as is regularly used in stellar observations, the factor is about 250,000. In a spectrum having a dispersion of 40 angstrom units[5] per millimeter (a typical value for a small stellar spectrograph) a wave-length difference of 0.000004 millimeter is stretched out to cover a whole millimeter. A spectrogram can be measured to about 0.001 mm, if placed on a carriage moved by an accurate screw and viewed through a low-power microscope provided with a cross-wire at right angles to the spectrum; and this distance along the spectrum corresponds to 0.04 angstrom units or about 3 kilometers per second.[6]

As might be expected, *o* Ceti, the patriarch of all long-period variables, has been observed more extensively than any other. According to a compilation by Joy,[7] reproduced in Table II, the velocity had been measured at fourteen maxima up to and including that of January, 1925. The general agreement of the results is excellent, the range among the determinations entitled to the higher weights being small. The appar-

[5] 1 angstrom unit = 0.0000001 millimeter.

[6] For a more complete account of the Doppler-Fizeau principle and its applications, the reader is referred to Dr. Campbell's book "Stellar Motions" published in 1913 by Yale University Press.

[7] *Mt. Wilson Contr.*, No. 311; *Astrophysical Journal*, **43**, 281, 1926.

TABLE II.

RADIAL VELOCITY OF o CETI AT MAXIMUM LIGHT.

Maximum		Mag.	Velocity km/sec	No. Plates	No. Prisms	Observer
Nov.	1897	3.7	+62.0	3	3	Lick, Campbell
Oct.	1898	2.9	62.8	2	3	Lick, Campbell
June	1902	3.5	66.	1	1	Lick, Stebbins
Dec.	1906	3.9	65.4	2	3	Ottawa, Plaskett
Dec.	1906	3.9	66.1	3	3	Bonn, Küstner
Dec.	1906	3.9	64.2	4	3	Yerkes, Frost
Dec.	1906	3.9	71.	2	1	Yerkes, Frost
Jan.	1915	3.9	70.	3	1	Yerkes, Frost
Jan.	1915	3.9	54.	2	1	Ottawa, Harper
Jan.	1915	3.9	63.7	1	1	Detroit, Merrill
Dec.	1915	3.5	63.4	5	4	Cape, Lunt
Dec.	1915	3.5	66.	1	1	Yerkes, Frost
Nov.	1916	3.8	63.3	3	1	Mt. Wilson, Joy
Sept.	1917	3.6	64.1	5	1	Mt. Wilson, Joy
Sept.	1917	3.6	66.	2	1	Yerkes, Frost
Sept.	1918	3.6	68.	2	1	Yerkes, Frost
Sept.	1918	3.6	70.	1	1	Ottawa, Harper
Sept.	1918	3.6	59.1	1	1	Mt. Wilson, Joy
Aug.	1919	3.3	65.8	1	1	Mt. Wilson, Joy
Aug.	1919	3.3	69.	1	1	Yerkes, Frost
June	1920	3.1	64.8	2	1	Mt. Wilson, Joy
March	1923	2.8	66.2	3	1	Mt. Wilson, Joy
Feb.	1924	4.7	62.0	4	1	Mt. Wilson, Joy
Jan.	1925	3.8	66.4	3	1	Mt. Wilson, Joy
Jan.	1925	3.8	+61.3	1	3	Mt. Wilson, Joy
Weighted mean			+64.5			

ent velocity is therefore nearly the same at all maxima. A small change during each light cycle will be described in another article.

The velocities in Table II were determined from the measured displacements of the dark or "absorption" lines in the star's spectrum. The bright hydrogen lines which are so conspicuous near the time of maximum light give different apparent velocities. The early Lick observations by Campbell and Stebbins showed that the bright lines not only of hydrogen but of iron, magnesium, and silicon, give displacements which are algebraically less than those of the dark lines by about 0.25A. In other words the atoms producing bright lines show an apparent velocity of approach of 15 km/sec with respect to those causing the dark lines. The same phenomenon was shortly thereafter found by Eberhard in the spectrum of χ Cygni, and it has since been observed repeatedly for these and numerous other variables.

Prior to 1916 the radial velocities of four long-period variables, o Ceti, χ Cygni, L_2 Puppis, and R Cygni, had been published. To these were added, in 1916, thirty-nine velocities determined by the writer at Ann Arbor with the 37½-inch reflector of the Observatory of the University of Michigan.[8] Ninety more were added from 1919 to 1923 by

[8] *Publications of the Astronomical Observatory, University of Michigan*, **2**, 45, 1916. This paper contains a brief historical account of spectroscopic observations of long-period variables.

observations with the 60- and 100-inch reflectors at Mount Wilson.[9] Since that time Miss Allen has measured and published radial velocities for fifteen additional southern variables from spectrograms taken at the Chile station of the Lick Observatory.[10] Published velocities are therefore now available for 148 long-period variables of classes Me and Se. Velocities for long-period variables of classes N and R have been published by Moore[11] and by Sanford.[12]

As noted in a previous paragraph, the bright lines give displacements which differ systematically from those of the dark lines. Which of these two groups of displacements yields more nearly the true radial motion? On general principles we should be inclined to trust the dark lines, for the reversing layer in which they arise seems likely to have the simpler and more stabilized relationship to the photosphere and the stellar interior. Observational data indicate the same conclusion.

The most definite single piece of evidence is offered by the double star X Ophiuchi, one component of which is a typical variable of period 335 days.[13] The duplicity of this star was discovered in 1900 at the Lick Observatory by Hussey, who found the position angle and distance to be 195°.2 and 0″.22, respectively. Twenty years later Van Biesbroeck at Yerkes showed the position angle to have decreased by 24°, the distance remaining the same. His conclusion that the variable is the northern component was confirmed by Gingrich from measurements of the combined image on parallax photographs taken at Mt. Wilson. The data are insufficient for a complete computation of the orbit, but reasonable approximations show that the orbital motion is slow, perhaps of the order of 2 or 3 km/sec, and that the orbital plane is nearly perpendicular to the line of sight. We therefore arrive at the useful conclusion that the radial velocities of the two components are practically equal. Hence, if we could measure the velocity of the companion star we could determine whether the bright lines or the dark lines in the spectrum of the variable yield the true value. A fortunate circumstance makes this possible, although the stars are so close together that their images cannot be separated for spectroscopic analysis. It happens that at maximum light the variable is two magnitudes brighter than its companion, while at minimum it is about three magnitudes fainter; thus at the proper phase the spectrum of either star may be photographed without serious interference from the other. The southern component is a K-type star which, observed during the minimum of the variable, gave a radial velocity of —70.8 km/sec. Displacements measured in the spectrum of the variable near maximum light were, bright lines —83.4 km/sec; dark

[9] *Mt. Wilson Contr.*, No. 264; *Astrophysical Journal*, **68**, 215, 1923.
[10] *Lick Observatory Bulletin*, **12**, 71, 1925.
[11] *Ibid*, **10**, 160, 1922.
[12] *Mt. Wilson Contr.*, No. 276; *Astrophysical Journal*, **59**, 339, 1924.
[13] *Mt. Wilson Contr.*, No. 261; *Astrophysical Journal*, **57**, 251, 1923.

lines —70.6 km/sec. According to this we should use the dark lines for velocity measurements.

A similar result is given by R Aquarii, an apparently typical long-period variable which is closely associated (in a manner imperfectly understood) with a small nebula. The velocity from the nebular lines coincides more nearly with that from the dark lines of the variable than with that from its bright lines.

Statistical investigations also favor the absorption lines as yielding essentially the true radial velocities. A solution for the sun's motion with respect to 83 Me variables, based on emission-line velocities, gave a K term[14] of —11.7 km; but a solution from the dark-line velocities of 133 stars (119 of class Me and 14 of class Se) gave a K term of +3.9 km; on omitting one very high velocity star, S Librae, the K term came out —0.2 km. The K term for 76 of the slower moving variables (derived from absorption-line velocities) was +1.3 km. Another selection of 68 slow-moving variables gave a K term of +1.1 km. It seems clear, therefore, that for a study of the motions of these stars the absorption-line velocities are to be preferred to those from the emission lines.

The bright lines are, however, usually much more intense than the continuous spectrum and thus may be photographed in fainter stars than the dark lines, which are of course measurable only when the continuous spectrum is recorded. Moreover, the bright lines are narrow and sharp and furnish such excellent marks for measurement that a velocity determination of satisfactory accuracy can be made from the two strong lines in the violet, Hγ and Hδ. These two lines, and some-

TABLE III.

Relative Displacements of Absorption and Emission Lines.

Star	Designation	Type	Period days	Abs. *minus* Em. km/sec
L_2 Puppis	0710*44*	M5e	140	+ 3
R Virgin.	123307	M4e	145	+ 9
R Arietis	021024	M3e	186	+12
R Leonis	094211	M8e	313	+17
o Ceti	0214*03*	M6e	332	+17
R Cassiop.	235350	M7e	432	+21
U Cass.	004047	Se	276	+12
R Gem.	070122	Se	370	+21
R Androm.	001838	Se	411	+28
V Cor. Bor.	154639	N3	357	+37
RS Cygni	200938	N3	401	+22
R Leporis	0455*14*	N6	440	+35

References:

Miss Allen, *Lick Observatory Bulletins*, **12**, 71, 1925.
Sanford, *Publications Astronomical Society of the Pacific*, **32**, 287, 1930.
Merrill, *Mt. Wilson Contr.*, No. 264; *Astrophysical Journal*, **68**, 215, 1923.

[14] The geometrical interpretation of the K term is an expansion (K positive) or a contraction (K negative) of the group of stars with respect to the observer. It is more likely, however, that it indicates systematic errors of measurement. A small value is usually assumed to mean that the measured velocities are not afflicted with serious systematic errors.

times Hβ, are, in fact, about all that can be photographed without unduly long exposures, except in a few dozen of the brighter variables. The correction to be applied to the measured displacements of these lines to give the true radial velocities of the stars must therefore be determined from those spectra in which both dark and bright lines can be measured. (Typical data are given in Table III.)

The velocities available for statistical discussion have either been measured directly from the dark lines (for the brighter stars) or, as in the majority of stars, reduced to a dark line basis by the application of a correction to the measured bright-line velocity. The displacements in spectra of class Me show a strong dependence on the period, and a graph of this relationship seems to furnish the best method of obtaining the desired correction to the apparent velocities derived from the bright lines.

The physical cause of the relative displacement of bright and dark lines remains unknown. The phenomenon is limited to variables of low temperature and low density but apparently it is independent of the exact composition or spectroscopic behavior of the reversing layer because it is essentially the same in spectra of classes Me, Se, and Ne.

The highly specialized character of the spectra and light-curves of long-period variables raises the question whether the motions of these variables differ in any way from the average motions of other stars. The spectroscopic determinations of radial velocity allow us to give a definite and very surprising answer to this query. We may consider first the common or group motion of the variables, and next their random or individual motions.

Space affords us no fixed marks to which stellar velocities may be referred; hence the motions we discuss are *relative*. As measured with the spectrograph stellar velocities are relative to the particular place of observation; but it is the universal custom to reduce them to the center of the sun by making corrections for the orbital motion and diurnal rotation of the earth. The first correction may be ± 30 km/sec, but the second does not exceed a few tenths of a kilometer per second. In all we now know the motions of a few thousand of the brighter stars relative to the sun. The center of mass of this group of stars may conveniently be adopted as a general reference point with respect to which we state the motion of other objects. For example the sun (taking with it the earth and the other planets) is said to be moving toward a point in the constellation Hercules, R.A. 270°, Dec. +30°, with a speed of 20 km/sec.

What is the group motion, if any, of the long-period variables with respect to the standard reference group of stars? We arrive at the answer to this question by a slightly round-about route: because we live in the solar system and make our measurements from it as from a moving platform, the method we adopt is to determine the motion of the sun with respect to both groups and compare the results. If the solar motion relative to both groups is the same, then, of course, the

variables are, in the mean, at rest among the ordinary stars; but if there is a difference (as actually turns out to be the case) the group of variables must be in motion with respect to the other stars. The speed and direction of the relative motion of the two groups can easily be calculated from the two results for solar motion. Results for the solar motion computed from groups of variables selected in different ways are given in Table IV. The values in the fifth line (for 146 stars) are to be preferred, but the others are included to show how well the results from other computations agree.

TABLE IV.

SOLAR MOTION WITH RESPECT TO LONG-PERIOD VARIABLES.

	No.	A_0	D_0	V_0
Long-period variables	63	275°	+42°	72 km/sec
	65	289	+46	65
	132	281	+33	52
	133	287	+41	55
	146	278	+35	57
Ordinary stars	3000±	270	+30	20

No. = number of stars.
A_0 = right ascension of the solar apex or point toward which the sun is moving.
D_0 = declination of the solar apex or point toward which the sun is moving.
V_0 = speed of sun.

Several interesting facts are involved in the interpretation of these figures. The high speed of the sun relative to the variables is a surprising feature, for it implies a considerable velocity, $57 - 20 = 37$ km/sec, for the variables as a group relative to the other stars. The close agreement in the directions of motion relative to the two groups (278°, +35°; and 270°, +30°) is a sheer coincidence,—the geometrical interpretation of which is very simple. Stated in words, Table IV shows that with respect to ordinary stars the variables as a group are passing toward a certain point in the southern hemisphere with a speed of 37 km/sec, while with respect to the same stars our sun is moving in almost exactly the opposite direction—herein lies the coincidence—with a speed of 20 km/sec.

Variables in the northern hemisphere are thus in general approaching us while those in the southern hemisphere are receding.[15] Those with the higher velocities show this tendency very strongly, as illustrated by Table V, in which a few of the highest measured velocities are listed. The positive sign indicates a motion of recession, the negative sign one of approach. The velocities are, of course, reduced to the sun. Variables of classes N[16] and S appear not to have extremely high velocities.

The "residual" or "peculiar" motion of a star is its own individual motion relative to the group to which it belongs. It is well known that

[15] For a more exact statement, substitute for *northern hemisphere* and *southern hemisphere, less than* 90° from the point R.A. = 278°, Dec. = +35°, and *more than* 90°, respectively.

[16] J. H. Moore, *Lick Bull.*, **10**, 160, 1922.

TABLE V.

HIGH VELOCITIES OF LONG-PERIOD VARIABLES.

Variable	1900 R.A. h m	1900 Dec. ° ′	Type	Period Days	Radial Velocity km/sec
R Arietis	2 10.4	+24 35	M3e	186	+114
R Pictoris	4 43.5	−49 26	M0e	165	+208
X Mono.	6 52.4	− 8 56	M4e	155	+157
S Carinae	10 6.2	−61 4	K9e	149	+298
S Librae	15 15.7	−20 2	M(2)e	192	+295
R Draco.	16 32.4	+66 58	M(5)e	246	−138
T Herc.	18 5.3	+31 0	M(3)e	165	−125
W Lyrae	18 11.5	+36 38	M5e	197	−174
RT Cygni	19 40.8	+48 32	M(3)e	190	−115
Z Cygni	19 58.6	+49 46	M5e	263	−165
RR Aquar.	21 9.8	− 3 19	M3e	180	−182

the average peculiar motion is not the same for stars of different types or magnitudes. It is, therefore, of interest to determine the value of this mean peculiar motion for long-period variables. For 133 variables of classes Me and Se the result comes out 33 km/sec. This is astonishingly high motion for very large, very bright, and supposedly very young stars. How it compares with other objects is shown by Table VI.

TABLE VI.

RANDOM MOTIONS OF VARIOUS TYPES OF STARS.

Spectral Type	Average Residual Radial Velocity km/sec
Planetary nebulae	37†
O5-O9	26‡
B	6§
A	11§
F	14§
G	15§
K	17§
M	17§
*M1e-M4e	47¡
*M5e-M6e	32¡
*M7e-M8e	24¡
Se	24¡
N	18¿

REFERENCES:

* Long-period variables.
† *Pub. Lick Obs.*, **13**, 182, 1918.
‡ *Pub. Dom. Astroph. Obs.*, **2**, 287, 1924.
§ *Stellar Motions*, p. 209, Campbell, 1913.
¡ *Mt. Wilson Contr.*, No. 264; *Astroph. J.*, **58**, 257, 1923.
¿ *Lick Bull.*, **10**, 167, 1922.

The data indicate that variables with earlier types (M1-M4) and shorter periods have the higher velocities. The correlation between period and velocity is incomplete in that stars of low velocity may have any length of period, but it is remarkable that very high velocities are largely confined to stars having periods between 150 and 250 days. This curious result is very difficult to interpret because rapidly moving objects (variables with periods about 200 days and spectral types about M3e)

seem so closely connected in the stellar spectroscopic sequence with two groups of stars having considerably slower speeds, namely, on the one hand variables having longer periods, and on the other hand, stars of classes M0 to M3 which are either constant in brightness, or, like α Orionis, vary irregularly through a small range.

The tendency of variables with high velocities to move along parallel paths in space appears to be an excellent illustration of the so-called "asymmetry" of stellar velocities. Stars with low speeds move nearly at random, but those with high speeds exhibit a preference for a particular direction. We may compare the situation with a bird's eye view of pedestrians on the streets of a city. Most of them are seen to be walking at a moderate rate, approximately equal numbers moving in all directions; but a few are running and these, attracted perhaps by a fire on the south side, are all going south.

The cosmic significance of the asymmetry of stellar velocities is, at present, but dimly disclosed. We think that a general rotation of the galactic system is involved and that the observed phenomena are dependent on the sun's position at a considerable distance from the galactic center, but the detailed application of this hypothesis to various groups of stars, in particular to the long-period variables with their high velocities, is by no means clear. Observational data are accumulating every year, however, and an increasing number of astronomers are studying the statistical problems. The outlook is therefore hopeful for a substantial extension of our knowledge of stellar motions in the near future.

Carnegie Institution of Washington, Mount Wilson Observatory.

Lake Erie Levels and Sun-Spots

By J. J. NASSAU and WILLIAM KOSKI

Although considerable work has been done to coördinate variations in rainfall, pressure, temperature, lake levels, and sun-spots, the derived correlations are still imperfect and not very well understood. It is not necessary to review here the history of the subject. A. Streiff,[1] Sir Richard Gregory,[2] and Jesse W. Schuman,[3] in recent papers have given an admirable idea of the work done up to the present. This paper concerns itself with the data of Lake Erie levels and their coördination with the sun-spot numbers together with the determination of the lags in their maximum and minimum values.

Monthly sun-spot numbers are available over a period of 180 years,

[1] The Practical Importance of Climatic Cycles in Engineering by A. Streiff: *Monthly Weather Review*, Vol 57, No. 10.

[2] Weather Recurrences and Weather Cycles by Sir Richard Gregory: *Monthly Weather Review*, Vol. 58, No. 12.

[3] Notes on Lake Levels by Jesse W. Schuman: *Monthly Weather Review*, Vol. 59, No. 3.

a period sufficiently long that one may suppose most of the long cycles are included. The real difficulty lies in procuring an authoritative record of lake level gagings over a similar period and to reduce them to a constant plane of reference. If the gagings have been influenced in any appreciable amount by artificial causes such as dams, locks, power developments or similar constructions, the effect of such works must be calculated and the lake level reduced as far as possible to natural conditions. Four lakes in the United States seem to satisfy the general requirements for such an investigation, that is, sufficient drainage area, length of period for which data are available and sufficient data regarding diversions. These lakes are Lake Superior, Great Salt Lake, Lake Erie, and Lake Ontario. A comparison of the advantages and disadvantages of these lakes was made from which Lake Erie was selected as it has by far the greatest drainage area (with the exception of Lake Ontario) and, although diversions of this lake are great, fortunately we have trustworthy means of its reduction.

Niagara River. While searching for records of water diversions, Senate Document 128[4] was found to have complete records of all diversions from 1860 through to 1926. The work has been compiled by the special International Niagara Board as a part of its report on the preservation of Niagara Falls. In an effort to compare actual conditions with those that would have prevailed had no diversions of any sort occurred, the Board calculated the discharge that would have occurred under natural conditions for the period mentioned above. These data are shown in Figure 1, being plotted for every three months having been made smooth by a two-year running average.

Lake Erie. The Lake Erie levels from 1860 to 1925 were furnished by the U. S. Lake Survey Office at Detroit and from 1925 to date were obtained from the Annual Reports of the Chief of the U. S. Engineers and from the Cleveland Office. These levels were corrected for diversion by interpolating from Tables 47 and 48 of Col. Warren's report.[5] The appropriate time lags between dates of diversion and dates of correction of such were also applied. The data were made smooth by the two-year running average and plotted for every three months.

"Sun-Spots." The yearly values of sun-spot relative numbers according to Wolfer[6] were utilized together with the dates of their maxima and minima which are given[7] to the nearest tenths of a year.

It is evident that the statistical data under consideration could have been treated in many other ways, but after several trials it was apparent that the general conclusions of this paper would not change materially by changing the mode of their treatment.

[4] Seventy-first Congress, Second Session.

[5] Congressional Documents, 66th Congress, 3rd Session.

[6] *Handbuch der Astrophysik,* Band IV, p. 95.

[7] *Handbuch der Astrophysik,* Band IV, p. 99.

Figure 1 shows all the data under discussion. The great similarity between Lake Erie levels and the Niagara River discharge is striking and in a certain way verifies the corrections applied to lake levels. For our purpose, either of those two curves may be used. They show a number of "primary" maxima and minima. Table I shows the year at

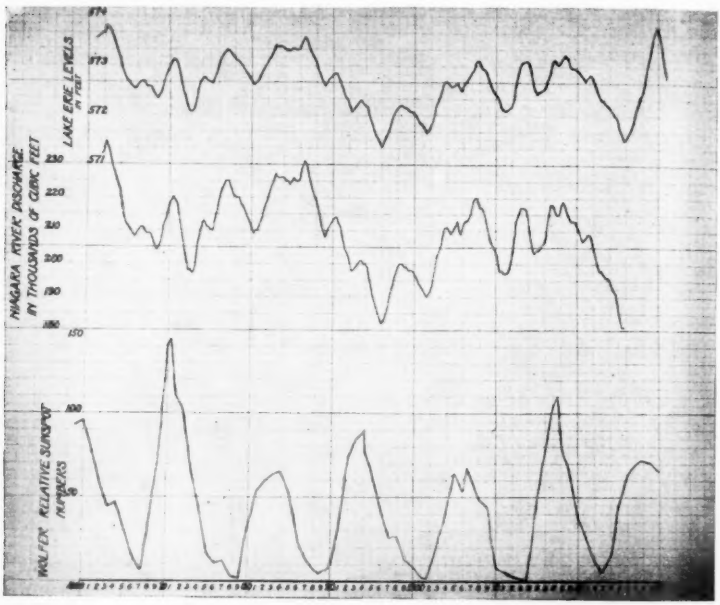


FIGURE 1.

TABLE I.

Dates of primary high and low water	Period	Dates of sun-spot maxima	Period	Lag
1819.0		1816.4		2.6
1838.6		1837.2		1.4
1862.5		1860.1		2.4
	10.1		10.5	
1872.6		1870.6		2.0
	14.1		13.3	
1886.7		1883.9		2.8
	9.5		10.2	
1896.2		1894.1		2.1
	11.8		12.3	
1908.0		1906.4		1.6
	10.7		11.2	
1918.7		1917.6		1.1
	11.3		10.1	
1930.0		1927.7		2.3
Average period = 11.25		Av. period = 11.27		
			Average lag = 2.03	

which these occurred together with a period between primary high and low levels.

The "low water of 1819"[8] and the "high water of August, 1838"[9] are shown in this table.

The times of sun-spot maxima are given in column 3 and, for the sake of comparison, the intervals between successive values are also given. The last column is the difference between columns 1 and 3 and shows a definite time lag. It is therefore evident that approximately *two years after each sun-spot maximum we have either a high or low lake level.*

The average in the period between sun-spot maxima for the given dates is 11.27 years and agrees very well with the period of high and low water.

Brooks[10] utilizing data of Central African Lakes from 1896 to 1922 finds a correspondence between high water levels and maxima of sun-spots without any lag. Having insufficient data for these lakes it is impossible to compare low water with other sun-spot maxima.

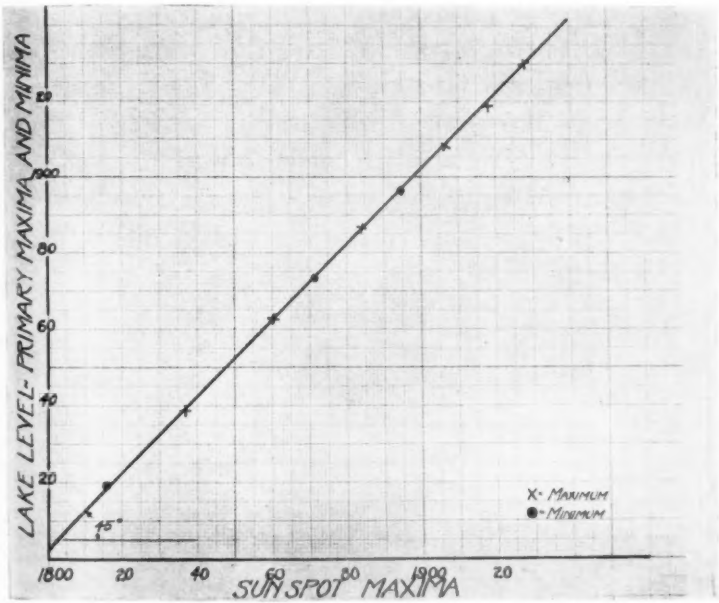


FIGURE 2.

[8] *Monthly Weather Review,* Vol. 55, pages 69-71.

[9] 1905 Report of the Chief of U. S. Engineers, p. 2782.

[10] G. E. P. Brooks on Variations in the Level of the Central African Lakes, Victoria and Albert; by Alfred J. Henry: *Monthly Weather Review,* Vol. 52, page 148.

The above coincidences are represented graphically in Figure 2. The dates of maximum sun-spot activities are plotted against the dates of the corresponding extreme values of lake levels. The line joining these points makes the angle of 45° with the axes showing a remarkable agreement in the periods, *that is where there is a variation in the period of sun-spots there is a corresponding variation in the period of lake levels.* The Figure also shows that the line does not go through the origin but meets the y-axis two units above it which is the two year lag.

The computed value of the coefficient of correlation for the data given in this figure is 0.99. Of course these results depend on our selection of maxima and minima of lake levels.

No attempt is made to give physical causes for these convincing relations (particularly where maxima of sun-spots coincide with either high or low water) which might be due to the combined effect of rainfall and evaporation or temperature as some meteorologists believe.[11]

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Aerial Photographs of the Moon's Shadow Obtained by the U. S. Navy During the Eclipse of August 31, 1932

By WILLIAM MALCOLM BROWNE

(COMMUNICATED BY CAPTAIN J. F. HELLWEG, U. S. NAVY, SUPERINTENDENT.)

Through the coöperation of the Bureau of Aeronautics the United States Naval Observatory was able to observe the Total Solar Eclipse of August 31, 1932, from the air, in addition to having a party on the ground. While the last few eclipses of the sun have been viewed from the air, there have been no accurately timed aerial motion pictures that show the progress of the moon's shadow over the surface of the earth.

Aside from the novelty of observing an eclipse of the sun from the air, there seem to be some possible advantages that cannot be attained as easily from the earth's surface.

In observing the times of second and third contacts by the usual methods, the observer notes the instants when the sun's disc is completely obscured by the moon and when it reappears. The observer is generally equipped with a telescope, a chronograph, and an accurate timepiece. The predicted times of second and third contacts are obtained from the apparent motions of the sun and moon together with the assumption that they are spherical bodies of certain assumed diameters. The roughness of the moon's limb may cause these times to vary by perhaps several seconds from what they would be if the moon were perfectly spherical. Two observers separated from each other by less

[11] Schuman, *M.W.R.*, Vol. 59, p. 102, and Brooks in *M.W.R.*, Vol. 52, p. 152.

than one mile will see the sun's disc disappear behind a different part of the moon's limb. Their observations of the times of second and third contacts will be affected by different amounts due to the phenomenon occuring at different points on the moon's limb. The only practical method of eliminating this source of error is to secure observations at a number of different locations.

However, if one can observe from an airship the time at which the moon's shadow passes over known landmarks on the earth's surface, it is a simple matter to obtain these data for a series of such landmarks scattered over an area several miles in extent. The results obtained from one motion picture camera on one airship would be equivalent to that obtained by perhaps half a dozen observers scattered over the same area on the ground. The only assumption is that these observations from the air will be as accurate as those from the ground.

The ability of an airship to fly over regions where it would be difficult to locate observers on the surface of the earth is another advantage.

In the event of clouds during the time of totality, an airship has a far better chance of avoiding them and obtaining observations through a break in the clouds than a ground party, which is generally fixed and cannot move quickly on short notice.

The sole purpose of this flight was to obtain accurately timed photographs of the moon's shadow as it passed over the surface of the earth in order to check the predicted location of the eclipse path and the time at which totality occurred.

Early Tuesday morning, August 30, the large Ford transport plane, that was to take the eclipse party up to New Hampshire, was outside its hangar at the Naval Air Station, Anacostia, D. C.

There were nine men in the party. Lt. C. M. Huntington was first pilot. Lt. H. W. Taylor was second pilot. Lt. D. S. MacMahan and Chief Photographer H. J. Baudu of the Naval Air Station were to operate the motion picture camera. Mr. W. L. Richardson of the Bureau of Aeronautics was to operate the still camera. Mr. Hayes of the Naval Research Laboratory went as an observer. Radioman S. F. Fogg and Plane Captain R. C. Sorrell assisted in various ways in addition to their regular duties aboard the plane. I had two chronometers to care for in addition to a collection of maps upon which the path of totality had been plotted.

We took off at 9:13 A.M., Eastern Standard Time, and landed at Concord, New Hampshire, at 2:25 P.M. An hour had been spent at Floyd Bennett Field, Long Island, where we had lunch and had the plane filled with gas. The rest of the afternoon was spent in going over the plans for the following day.

We decided to fly at an altitude of about 14,000 feet on a course that would place the city of Concord, New Hampshire, in the photographs during the time of totality. The southern edge of the path of totality passed through Concord, so the photographs should contain the moon's

shadow projected on an ample supply of easily recognizable landmarks. An area of several square miles would be visible in each picture.

Since the doorway through which we would photograph was on the right hand side of the plane, we thought it best to fly in a northwest direction, parallel to the southern limit of the path of totality, and a short distance outside of it. This plan would give us a much better view of the approach and recession of the shadow than would be obtained by flying in the opposite direction and inside of the southern limit.

The tripod of the motion picture camera was to be lashed securely in the open doorway. The still camera was to be held by Mr. Richardson who could squat in the doorway beneath the tripod.

In order to obtain the exact time at which the photographs were taken I devised the following plan: Since time signals could be received on the plane, I used a sidereal chronometer which was compared with the time signals by the eye and ear method. The coincidence of the chronometer beat with the time signal tick every three minutes made it possible to get the error of the sidereal chronometer with an accuracy better than one tenth of a second. The mean time chronometer was compared with the sidereal chronometer in a similar manner. The error of such a comparison was only two or three hundredths of a second.

The still camera was a seven-inch Fairchild with an F/4.5 lens. It contained a small watch indicating time to about one-fifth of a second. The face of this watch was photographed in one corner of the film as each picture was taken so that the time was automatically recorded. This watch was compared with the chronometer before and after the eclipse.

The motion picture camera was a motor-driven Akeley, with an F/1.9 lens of about two inches focal length. In order to obtain the time at which each individual frame was exposed, I planned to hold the sidereal chronometer so that it could be photographed just before and just after photographing the passage of the moon's shadow. It was necessary to turn the camera and change the focus to do this. The time at which each frame was exposed could then be obtained by interpolation.

The anxiety over the coming events, coupled with the proximity of our hotel to a freight yard, made sleep a difficult task that night. When we awoke the following morning we were still further dismayed. The freight yard, so near and noisy during the night, had disappeared from view. A thick blanket of fog hid everything. After breakfast the fog had nearly vanished but the sky was completely overcast. By noon there were a few breaks in the clouds and it began to look hopeful.

At 2:45 P.M. we took off from the Concord Airport and climbed until at an elevation of 4000 feet we were on a level with the clouds. By this time the sky was fairly clear except for occasional clouded areas. Lt. Huntington thought it advisable to stay below the clouds so that they could not obscure our view of the earth's surface. I plotted the course for the plane six-tenths of a mile outside of the southern limit and desig-

nated the proper time to be directly opposite Concord. After giving the map and directions to the pilots I went back near the open doorway of the ship and waited.

The sunlight was becoming noticeably weaker, slowly at first, then more rapidly as the time of totality approached. The radioman held my watch and a flashlight illuminating it so that I could have both hands free to hold the chronometer. Baudu trained the motion picture camera while Lt. MacMahan changed the focus of the lens and held two flashlights on the chronometer face while it was being photographed. I signaled to Baudu to start the camera when my watch indicated the proper time. The camera was already trained and focused on the chronometer which I held firmly against a partition near the open doorway. After fifteen seconds had elapsed I signaled again. The camera was quickly refocused and turned downward to catch the moon's shadow. Another signal two minutes and ten seconds later and the camera was again trained and focused on the chronometer where it ran for about ten seconds before the 200 feet of film were used up.

Mr. Richardson exposed the still camera a number of times during this period but knew it was useless, as the illumination was much too faint to obtain any image with an F/4.5 lens and one-fiftieth of a second exposure, which was the longest available on the camera. Mr. Richardson had an excellent view of the landscape beneath, but he saw no definite shadow edge. The effect was a gradual darkening of the landscape beneath the plane until the time of totality, and then a gradual brightening after totality.

During the period of totality no clouds obscured the sun, although many were near by. The corona and Baily's Beads were visible to Lt. Taylor and Mr. Hayes who were at liberty to look in the direction of the sun. Both of them said that one of Baily's Beads remained visible during the entire time. I was surprised to find that we were not over Concord at all during the period of totality. Lt. Huntington had noticed a cloud which persisted in casting its shadow over most of the city of Concord just before the moon's shadow was due. To avoid this he purposely delayed the course of the plane. What we actually photographed was the town of Suncook, New Hampshire, about six miles southeast of Concord and also located practically on the southern limit.

We had planned to land at the Concord Airport in order to replace the door of the plane, but the clouds increased so rapidly after totality that this plan was abandoned, and the plane was headed back to New York. After a rather adventuresome flight, during which the clouds nearly forced us down, we landed at Floyd Bennett Field about six that evening. The following morning we left for Washington, arriving at the Naval Air station about 1:30 P.M.

The motion picture film was developed immediately and after a preliminary inspection it seemed to contain nothing of scientific value. It was only after a careful examination that I found several landmarks in

the pictures that gradually became invisible and then returned to view again. They can be seen with certainty only on the original negative.

The times of disappearance and reappearance of these landmarks on the negative will be influenced by a systematic error depending upon the speed of the lens, the character of the landmarks, and a number of other factors. However, if this systematic error should make the disappearance one second early, it would make the reappearance one second late, so the average of the two is free from such an error. The results obtained indicate that the systematic error affecting the times of disappearance and reappearance was quite small.

These landmarks disappeared six and one-tenth seconds after the predicted time of second contact. They reappeared one and five-tenths seconds after the predicted time of third contact. This indicates that the moon's shadow was late by approximately three and eight-tenths seconds.

These landmarks were invisible on the negative for a period of nine and four-tenths seconds. The predicted duration of totality was fourteen seconds even. If we assume that the nine and four-tenths seconds is a true value of the duration of totality at these landmarks, we may conclude that the predicted location of the southern limit was about four-tenths of a mile in error. The visual observations of Baily's Beads confirm this result.

Apparently this is the first time that the moon's shadow has been located on the surface of the earth by means of aerial photography with a degree of accuracy approaching that obtained by the usual methods.

U. S. Naval Observatory, Washington, D. C., December, 1932.

Planet Notes for May, 1933

By CLIFFORD E. SMITH

The *Sun* will be moving northeast from the central part of Aries to the central part of Taurus. Its distance from the earth will increase about .7 million miles so that at the end of the month its distance from the earth will be about 94.3 million miles. The position of the sun on the first and last days of the month will be, respectively: R.A. $2^h\,31^m$, Decl. $+14°\,52'$; R.A. $4^h\,30^m$, Decl. $+21°\,49'$.

The phenomena of the *Moon* will occur as follows:

First Quarter	May	2 at	5 P.M.	C.S.T.
Full Moon		9 "	4 P.M.	"
Last Quarter		16 "	7 A.M.	"
New Moon		24 "	4 A.M.	"
Perigee		10 "	12 M.	"
Apogee		25 "	5 A.M.	"

Mercury will be moving northeast from central Pisces, across Aries, to central Taurus. At the beginning of the month its apparent diameter will be about 6.5 seconds of arc, and its distance from the earth will be about 95 million miles. Early in the month it will rise about an hour and a half before the sun, but by the end of the month it will be near the sun in apparent position since superior

conjunction will occur on May 28 at 1:00 P.M., C.S.T. During the month the distance from the earth to Mercury will increase about 50 million miles. On May 6 at 9:00 A.M., C.S.T., Mercury will be in conjunction with Uranus (Uranus 2°.2 N), and on May 23 at $6^h\,8^m$ P.M., C.S.T., it will be in conjunction with the moon (Mercury 5°.4 S).

Venus will be near the sun in apparent position since conjunction with the sun occurred in April. At the end of the month it will set about forty minutes after the sun.

Mars will be moving with an apparent southeasterly motion in Leo. At the beginning of the month its distance from the earth will be about 90 million miles, and its apparent diameter will be about 10 seconds of arc. During the month its distance from the earth will increase about 20 million miles, and its apparent diameter will decrease about 2 seconds of arc. During the middle of the month Mars will be on the meridian about 7:00 P.M., Standard Time. On May 4 at $10^h\,51^m$, C.S.T., Mars will be in conjunction with the moon (Mars 2°.0 N), and on May 16 at 3:00 P.M., C.S.T., it will be in conjunction with Neptune (Mars 0°.8 N).

Jupiter will be in eastern Leo. Its apparent motion will be retrograde until May 10 and thereafter direct. During the middle of the month the distance of Jupiter from the earth will be about 460 million miles, and its apparent diameter will be about 36 seconds of arc. During the middle of the month it will be on the meridian about $7^h\,30^m$ P.M., Standard Time. On May 5 at $4^h\,39^m$ A.M., C.S.T., Jupiter will be in conjunction with the moon (Jupiter 2°.4 N).

Saturn will be in eastern Capricornus. During the first part of the month Saturn will rise about midnight since it will be at quadrature west on May 6 at 8:00 P.M., C.S.T. During this period its distance from the earth will be about 900 million miles, and its apparent diameter will be about 15 seconds of arc. On May 15 at $2^h\,31^m$ P.M., C.S.T., Saturn will be in conjunction with the moon (Saturn 0°.8 N).

Uranus will be near the sun in apparent position since conjunction with the sun occurred on April 13.

Neptune will continue in Leo. Its apparent motion will be retrograde until May 19 when it will become direct. Its apparent diameter will be about 2½ seconds, and its distance from the earth will be about 2800 million miles. On May 28 at 12:00 P.M., C.S.T., Neptune will be at quadrature east and thus will set about midnight. On May 4 at $4^h\,11^m$ P.M., C.S.T., it will be in conjunction with the moon (Uranus 1°.2 N), and on May 16 at 3:00 P.M., C.S.T., Neptune will be in conjunction with Mars (Mars 0°.8 N).

OCCULTATIONS

(Contributed by the office of the *American Ephemeris.*)

Date 1933		Star	Mag.	IMMERSION Greenwich C.T.	*a*	*b*	Angle E from N	EMERSION Greenwich C.T.	*a*	*b*	Angle E from N
				h m	m	m	°	h m	m	m	°
		OCCULTATIONS VISIBLE IN LONGITUDE +72° 30′, LATITUDE +42° 30′.									
May	4	υ Leo	5.0	1 53.8	−0.7	−2.3	150	3 0.6	−1.2	−1.7	283
	11	τ Sco	2.8	8 23.7	−1.7	−1.6	136	9 14.9	−0.7	−0.3	231
	29	9 Cnc	6.2	2 16.4	−0.5	−0.7	59	2 50.5	+0.9	−2.4	346

Occultations Visible in Longitude +91° 0′, Latitude +40° 0′.												
May	11	τ Sco	2.8	7	54.0	−1.8	−1.0	136	8	54.2	−1.7	−0.1	241
	29	9 Cnc	6.2	2	8.9	−0.6	−1.3	93	3	6.6	+0.3	−2.1	318
	31	ψ Leo	5.6	1	56.8	−1.5	−1.2	92	2	57.0	−0.1	−2.6	337
Occultations Visible in Longitude +120° 0′, Latitude +36° 0′.												
May	1	176 B.Gem	6.3	6	47.8	+0.3	−1.7	127	7	41.2	+0.3	−1.2	275
	1	181 B.Gem	6.0	7	18.7	+0.6	−1.8	139	8	5.4	+0.4	−0.9	262
	9	236 G.Vir	5.7	2	37.0	−1.4	+3.0	62	3	6.7	+0.8	−2.5	0
	12	210 B.Sco	5.8	13	49.4	−1.0	−0.8	83	14	53.6	−0.5	−0.7	254

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

Popular Astronomy most correctly gives opportunity for the publication of papers which present new view-points even though these are in serious conflict with what is generally accepted at the moment as more probable. The writer would be one of the last persons to desire this policy changed, realizing as he does how faulty and temporary are many of our current hypotheses. The serious student, be he amateur or professional, should always be given a respectful hearing. But after this has been done, it sometimes seems wise to consider some of the arguments which have been advanced in such papers, for the benefit of others who may not understand their full implications.

In this spirit the writer desires to discuss a paper which appeared in the March number of Popular Astronomy entitled "The Distribution of Meteorites," by J. B. Penniston. It is also felt that a further discussion of this important topic would not be amiss.

First let us see what data on meteorites have been recorded. Up to 1923 about 850 falls and finds were available for study. Of these only 14 siderites (iron meteorites) had actually been seen to fall, whereas nearly all of the stone ones were seen. In 1915 Farrington stated that of the 634 then-known meteorites, 256 had been found in Europe and 177 in the United States, or 68% in about one-eighth of the land area of the earth. However, the whole number found in the western hemisphere is 256, of which 182 were iron and 74 stone; of the 378 in the eastern hemisphere, 79 were iron and 299 were stone. It is regretted that there is no complete summary up to date, but there is no reason to believe that the new falls would seriously affect conclusions based upon the above figures.

Mr. Penniston argues that we have no right to attribute this distribution to chance finds, that we must simply accept it as a fact proving unequal distribution of falls. He quotes Sir Isaac Newton in support of his position, but Newton's words do not happen to fit the question under discussion. The present writer will

not reply to the parts of Mr. Penniston's paper in which possible strange and unknown actions of gravitation are hinted at, but will limit his remarks to the other phases.

Now let us see what may easily be inferred from the actual data. As very few of the iron meteorites were seen to fall, nearly all of the 182 in our hemisphere were found after more or less considerable intervals of time. This is not true of stony meteorites, most of which must be picked up promptly or lost forever. From the relative time intervals concerned, we note at once that very many stony ones fall to each iron. Therefore *if* we could find all the vastly more numerous stony ones which fell during the same long interval represented by the irons, it is obvious that the present map showing the places of fall would look entirely different.

Iron meteorites in America were rarely picked up in the early years, because the Indians did not have any use for meteoric iron, and the population of America was very scant until the last century; the opposite was true in Europe, where iron was valued 3000 years ago. We at once see why irons survived here in greater numbers than in Europe or in other thickly settled countries of the eastern hemisphere. There they were picked up; here they were not, even if they were found. The above reasoning will indicate pretty clearly why relative proportions of stony and iron meteorites differ so greatly in the two hemispheres.

There is another factor in distribution in this hemisphere. In North America we have certainly one area, and, in view of the remarkable elliptical "craters" found along the Carolina Coast, probably two areas upon which the nuclei of comets have struck. All information as to comets leads us to believe that a comet's nucleus gradually loses its separate particles (or masses) which become meteors at some, and eventually great, distances from the parent nucleus. Hence there is every reason to suppose that when the great mass struck at Canon Diablo, Arizona, other pieces, originally an integral part of the nucleus, came down some little time either *before* or *after* the main fall. As the earth had meantime rotated, these would fall at considerable distances. This general type of idea was advanced by W. H. Pickering in 1919.*

For the Carolina "craters," if eventually these prove to be meteoric, we must admit a vastly larger comet. Many of the numerous irons now found in the mountain regions to the west would simply be "trailers" of the main body, which would of course fall to the west due to the direction of the earth's rotation. The "preceders" in this case perforce fell in the Atlantic where no trace can be found. Both of the above catastrophes would further help to explain the numbers and local distributions of iron meteorites in the United States.

As to there being zones of preferential fall upon the earth, a person knowing little of celestial mechanics, of the data on meteorite orbits, and of the actual paths taken by such bodies as they come through the atmosphere, might perhaps think that if such bodies moved approximately in the plane of the ecliptic, then certain zones of the earth's surface would have better chances for being struck. Such reasoning is, however, utterly fallacious. Even were meteorites confined approximately to the plane of the earth's orbit, that would not mean in the least that they would not fall upon all zones of the earth's surface. Mr. Penniston seems unaware that we are able to calculate, and in some cases with fair accuracy, the plane and direction of motion of meteorites as they fall. We further know that all meteoric bodies, in the last part of their paths, move in hyperbolae with the earth's center

*Pop. Astr., xxvii, April, 1919.

as a focus, the sun by then having become merely the perturbing body, the earth the dominant center of attraction. We further know the average relative velocity, within fair limits of accuracy, with which these bodies strike us. Such velocities could not be acquired by a body falling under the earth's gravitation from any nearby "condensation centers," even were we able to set up any conditions under which these centers could exist.

The above facts being true, we know that meteoric bodies, which include meteorites, strike the earth at all possible angles and at all hours of the day and night. We are thus absolutely justified in stating that about three-fourths of all fall in the water, as water covers about that proportion of the earth's surface.

In the last few years the writer has received reports of several authenticated cases of large meteorites falling into the ocean near ships. He also calculated the path of a great fireball tracing it close to the surface of Lake Michigan, into which the debris certainly fell. A meteorite fell upon the ice of a lake in Sweden in 1869. Hence we know of some metorites falling into bodies of water, and when we consider the few people upon the oceans compared to those upon land, the small proportion of recorded cases is not surprising.

One more statement of Mr. Penniston's must be quoted: "The fact that meteors which reach the earth as meteorites are to be seen in the last stages of their flight moving in various directions proves nothing, for we know that the smaller meteors during their visible flight frequently have erratic or irregular orbits."

The last statement, as it happens, is positively contradicted by observation: not 2% of meteors show the least irregularity. The first part of the statement is contradicted by the ordinary laws of mechanics. The present writer does not think it necessary to consider other similar statements. It was thought, however, that the subject as a whole was really worth discussion.

It may be added that all reported falls of meteorites should be promptly investigated and witnesses questioned before they have had time to forget. The gathering of accurate data is a difficult task, but it is really surprising how much scientists have been able to learn of meteorite paths, remembering of course that witnesses are always taken unawares.

We take pleasure in welcoming the following new members:

R. B. Butler, 963 Kenyon Avenue, Plainfield, New Jersey.

Joseph Leerman, 3019 E. Baltimore Street, Baltimore, Maryland.

The accompanying table contains some of the radiants derived from observations in 1927 by the A.M.S. Radiants No. 1555 and 1556 are from the work of V. Anyzeski of New Haven, Connecticut. All the rest are from that of Sterling Bunch, then observing at Ft. Worth, Texas. The other 1927 radiants will appear when their derivations have been checked.

RADIANTS.

A.M.S. No.	Date 1927 (G.M.T.)	α °	δ °	Meteors	Wt.	Remarks
1555	Nov. 25.6	42	+32	4	Fair	V. Anyzeski
1556	Nov. 19.6	50	+36	4-5	Fair	V. Anyzeski. See 1301?
1557	June 23.8	213	+56	3	Fair	S. Bunch. (1557-1574 from his observations.)
1558	June 26.7	316	+22	3	Poor	
1559	Oct. 19.8	88	+15.5	44±	Fair	Orionids (dif.)
1560	Oct. 19.8	44	+10	5	Good	See 1270?, 1284?
1561	Oct. 19.8	46	— 3	4	Fair	See 82?, 675?

1562	Oct. 19.8	57	+16	6-8	Fair	
1563	Oct. 23.8	59	+12	5-7	Good	See 1310, 1311?
1564	Oct. 23.8	42.5	+10.5	7-8	V. Good	
1565	Oct. 23.8	93.5	+15.5	26+	Fair	Orionids
1566	Oct. 23.8	48	+ 5	5-10	Good	
1567	Nov. 10.7	39	+ 4	4	Fair	
1568	Nov. 17.8	151.5	+23	8	Good	Leonids
1569	Nov. 17.8	46	+31	5+	Good	
1570	Nov. 17.8	57.5	+17.5	4	Good	See 1309?
1571	Nov. 26.8	88	+18	7	Good	
1572	Nov. 26.8	105	+28	6	Poor	
1573	Nov. 26.8	139	+53	4	Good	
1574	Nov. 26.8	112	+ 9.5	3	Good	

Flower Observatory of the University of Pennsylvania,
Upper Darby, Pennsylvania, 1933 March 16.

On the Formation of Meteoric Craters

By C. C. WYLIE

Observation gives us the following basic facts on the fall of meteors and meteorites. For ordinary shooting stars, the height of disappearance averages about sixty miles. For fireballs, the height of disappearance is forty miles, or lower. Where meteorites are recovered, the height of disappearance averages about fifteen miles. For the Paragould meteor (where the largest meteorite observed to fall was recovered) the height of disappearance was about five miles. It is reasonable, therefore, to assume that for a meteorite much larger than the Paragould, the ball-of-fire appearance would continue to the surface of the earth. Estimates of velocity are weak as the meteors are unexpected, but there is little evidence of an appreciable decrease in velocity before the time of disappearance. This holds even for brilliant meteors where meteorites have been recovered. A few observations do, however, indicate some decrease.

For meteorites which have been heard to strike the earth, the striking velocity is less than the velocity of sound, and appears to be approximately the velocity which a body of that size and weight would attain after dropping from a great height. A meteoric stone strikes in an almost vertical direction, with practically the velocity and direction it would have attained had it been thrown from an airplane flying high. This holds whatever the original direction and velocity of the meteor. A meteorite weighing a few ounces would normally be found lying on top of the sod as though it had been tossed there by a child. The velocity of striking is not appreciably different from that of a hailstone of the same weight. At Tilden, a 9-pound stone penetrated dry earth about five inches; a 46-pound stone went down about fifteen inches; and a 110-pound stone went down in hard clay to a depth of three feet and ten inches. The Paragould stone, weighing 800 pounds, went down slightly more than eight feet. From these figures, one would assume that the larger meteorites, weighing tons, would penetrate much farther. It might be guessed that a meteorite weighing 36 tons would penetrate to a depth of 40 feet or more. However, the large iron meteorites have usually been recovered near the surface. An explanation offered is that the large meteorites found have struck at a low angle, so that most of the penetration was horizontal rather than vertical. Small meteorites are observed to strike in a nearly vertical direction, but a 36-ton object might strike at a low angle. Erosion has, in the course of thousands of years, without doubt removed some soil also. The surface en-

countered is without doubt important. The two largest meteorites known are the Cape York, 36 tons, and the Grootfontein, more than 50 tons. The Cape York probably had its fall cushioned by the snow and ice of northern Greenland. The Grootfontein meteorite is a flat block of metal, and consequently fell more slowly because of the increased air resistance. It fell on soft limestone, which stopped it rather quickly, yet without shattering.

Several craters generally thought to have been formed by the impact of giant meteorites are now known. The famous Meteor Crater near Winslow in Arizona is the best known. It is a cup-shaped depression, roughly circular in shape, about 4,000 feet across, and 600 feet deep. The rim is about 150 feet above the surrounding plain. The rock strata are tipped upward on the southeastern rim, suggesting that the crater was formed by the impact of an object striking from the northwest. Around the crater within a radius of some six miles, thousands of pieces of meteoric nickle-iron have been picked up. The smaller pieces weigh only a fraction of an ounce, and the larger masses weigh more than a thousand pounds. Several tons of this material have been picked up. Inside the crater, almost no meteoric material has been found, but borings near the southeastern rim strike, at a depth of about 700 feet below the bottom of the crater, a hard object, or objects, and an analysis of the material shows the presence of nickel. This indicates that there is meteoric material at that depth below the crater. The borings also bring up a large amount of "rock flour," or pulverized stone, and pumice-like silica glass, which it is assumed was formed by the fusion of the sandstone at the time of the impact of the giant meteorite.

An expedition to the Stony Tunguska River in Central Siberia found a region where it is assumed a great meteor struck on June 30, 1908. Trees are felled radially outwards from the central part of this region to a distance of more than 30 miles. In the center of this area is a group of ten craters, diameters from 30 to 150 feet, the depth averaging about ten feet. No meteorites were found in this region. Near Odessa in Texas there is a roughly circular crater with a diameter of about 530 feet near which a mass of meteoric iron was found. A group of craters have been found in the Baltic, the largest being more than 300 feet across and 150 feet deep, with its rim some 12 feet above the surrounding ground. Six smaller craters are in the vicinity.

Near Henbury in central Australia is a group of thirteen craters, the largest measuring about 660 by 360 feet, with a depth of 50 to 60 feet. The others are approximately circular in outline with diameters ranging from 30 to 250 feet. Surrounding these craters, hundreds of pieces of meteoric iron ranging in weight from a fraction of an ounce to 270 pounds have been found. There is little doubt that most of the preceding craters were formed by the impact of giant meteorites.

The most recently studied of these possible meteoric craters are the Carolina "Bays" along the coastal plains of North and South Carolina. There are hundreds of these circular or elliptical depressions in this area. They were first called to the attention of scientists in 1895, but the results of a careful study have only recently been published. The depressions studied range in size from about 500 feet in diameter to an extreme length of more than 8000 feet. The ellipticity of the depressions increases with the size. The long axes of these depressions are nearly parallel throughout the entire region, the direction being very nearly 45° south of east. The southeastern rims are higher and are more conspicuous than the northwestern. The explanation suggested by Melton and Schriever for these depressions is that they were formed by the impact of a swarm of giant meteorites

coming at a rather low angle from the northwest.

Let us now consider the resistance of the air to the fall of meteorites of various sizes. The weight of a spherical iron meteorite in tons is approximately the cube of the radius expressed in feet. The weight of the atmosphere displaced during a vertical fall is in tons approximately three times the square of the radius expressed in feet. The ratio of the weight of the meteorite to the weight of the air displaced is, therefore, approximately one-third R, where R is the radius expressed in feet. For an iron meteorite one inch in diameter, the ratio is 1/72; that is, the weight of the air displaced during a vertical fall is 72 times the weight of the meteorite. This indicates an almost complete loss of the original high velocity, in agreement with observation. Such a meteorite would weigh about three ounces. A stone meteorite would weigh about half as much as an iron, and the ratio, therefore, of the weight of the atmosphere displaced to the weight of the meteorite would be doubled. For an iron meteorite six inches in diameter, the ratio of the atmosphere displaced during a vertical fall to the weight of the meteorite would be six. Such an iron meteorite would weigh about 30 pounds, and would be one of the heaviest irons for which the date of fall is known. For an iron meteorite two feet in diameter, the ratio of the weight of the air displaced during a vertical fall to the weight of the meteorite itself would be three. Such a meteorite would weigh one ton, and would strike at a much higher velocity than any meteorite for which the date of fall is now known. There would be a very great slowing down of the original velocity in displacing three times its weight of atmosphere, but the ball-of-fire appearance might persist to the surface of the earth. An iron meteorite with a radius of three feet, or diameter six feet, would weigh 27 tons, and displace just its own weight of atmosphere in a vertical fall. The Cape York meteorite of weight 36½ tons, and the Grootfontein, of weight 50 or more tons, are therefore of a size to displace just a little less than their own weight of atmosphere, if spherical. A meteorite of radius fifteen feet, or diameter thirty feet, would weigh five times as much as the atmosphere displaced in a vertical fall. Such an iron meteorite would weigh more than 3000 tons, fifty times the weight of any yet found. An iron meteorite of diameter 100 feet, or radius 50 feet, would weigh seventeen times as much as the air displaced in a vertical fall, and would necessarily strike with its original velocity diminished very little. Such a meteorite would weigh more than 100,000 tons, and the energy would be very nearly sufficient to produce the famous crater in Arizona.

Calculations show that the kinetic energy of a meteorite striking with velocity of 2.3 miles per second would be equal to the explosive energy of the same weight of nitroglycerin. The kinetic energy increases as the square of the velocity so that the energy of a meteorite striking at ten miles per second would be equal to 19 times the explosive energy of its weight in nitroglycerin. At 25 miles per second, the energy would be equal to 120 times its weight in nitroglycerin, and if a meteorite should strike at forty miles per second, the energy would be equal to 306 times that of an equal weight of nitroglycerin. A high powered rifle fires a bullet at about one-half mile per second. Even at this speed, a bullet fired against a hard target is either melted or pulverized. The minimum velocity with which a meteorite would enter our atmosphere is about ten miles per second, and the maximum velocity is forty miles per second, or possibly even higher. It appears, as we have just shown, that large meteorites strike the surface of the earth with very nearly the velocity with which they enter the atmosphere. At ten miles per second, a much higher velocity than we can produce with a rifle, it is evident that

the meteorite, on striking hard rock, would be melted and shattered. The enormous kinetic energy would presumably mean that a large part of it would be not only melted, but vaporized, with explosive suddenness. The resulting explosion would make a hole approximately equivalent to that produced by a quantity of nitroglycerin whose explosive energy equals the theoretical kinetic energy of the meteorite. Much of the meteorite, and much rock, would be vaporized. In the resulting explosion, many small unmelted fragments would be blown from the crater over the adjoining country, and many others would presumably be buried in the crater; but it is hard to conceive of any large mass remaining unshattered.

We mentioned as a fact of observation that small craters are nearly circular, while some of the larger are distinctly elliptical. This is especially noticeable in the Carolina "Bays." The following explanation is suggested for this difference. Let us assume that the meteorites making these "Bays" struck at a relatively low angle. The smaller craters were produced by relativly small meteorites, the main mass of which was completely shattered and exploded almost instantly at the time of striking. For the relatively larger meteorites, the complete shattering consumed an appreciable time, during which the meteorite drove into the rock for some distance. As another way of putting it, we may assume that the smaller depressions were produced by meteorites usually shattered and vaporized while driving only twenty-five to fifty feet through soil and rock. The explosion produced a hole perhaps 500 feet in diameter, and the twenty-five to fifty feet travelled caused little or no noticeable elongation. The largest meteorites drove through soil and rock 3500 feet or more before the process of vaporization and explosion was completed. The explosion produced a crater about 4000 feet across, and the distance travelled during the explosion made the length 8000 feet.

University of Iowa, March 22, 1933.

Concerning Bacteria in Meteorites

Wide publicity has been given to the announcement by Dr. Chas. P. Lipman of the existence of living bacteria in the interior of meteorites and his opinion that meteorites carry these living forms from other parts of the universe.

I have read carefully his paper as published in the *Novitates* of the American Museum of Natural History and I must confess that I find it not at all convincing. Not only are the structures of all known meteorites such as to make the existence of life in them seem impossible; but I fail to find in Dr. Lipman's experiments any good evidence of the presence of bacteria in the interior of those specimens which were used in his experiments.

That perfectly good bacterial cultures were obtained in his culture media cannot be questioned but that these came from spores or active forms which had been living within them previous to their arrival on the earth is another question entirely. Anyone who has spent much time in the bacteriological laboratory or who has had experience in testing foods for contamination will at once question Dr. Lipman's technique as a safe method of arriving at a final solution to the problem he has attacked. It is my opinion that if Dr. Lipman were to draw a red hot clinker from his furnace, allow it to cool, and subject it to the same tests he would be rewarded by just as healthy cultures of bacteria as those which he obtained in his meteorite experiments.

It is very questionable whether all contamination from the air can be excluded during the process of crushing a rock in a mortar; but even if this were possible meteorites are not at all impervious to air nor to particles as minute as dessi-

cated bacteria. A freshly fallen meteorite, in making its adjustments to terrestrial conditions would naturally absorb into its pores a certain amount of bacteria-laden air.

I see not the least evidence of extra-terrestrial life revealed by the experiments referred to.

H. H. NININGER.

1955 Fairfax Street, Denver, Colorado.

Quadrantids, January 1-3, 1933

It is almost impossible to get good weather about January 1-3, but this year all three nights were good, and observations were made on all three nights. This shower is of very short duration and this year began on January 2, possibly in our daytime, and was mostly over before daybreak on January 3, the probable duration being about 12 hours. None were seen on the night of January 1 and very few January 3. The radiant is evidently a large area with two possible centers, and shifts rapidly northeastward. Five head-on meteors were observed and they were quite widely separated. The shower is very fine and active with some fine fireballs, which seem to continue throughout the month, a large number being seen this year. The tabulated results follow:

Magnitude	6	5	4	3	2	1	0	—1	—2	—3	—4	—5	—6
January 1	0	0	0	0	0	0	0	0	0	0	0	0	0
January 2	20	34	4	6	22	5	12	5	0	2	0	0	1
January 3	2	0	0	2	2	0	0	0	0	0	0	0	1

Total January 2 111 Quadrantids, 6 trails
Total January 3 7 Quadrantids

Jan. 2	12:00 to 1:00 A.M., E.S.T., cloudy, cleared sharply.						
	1:00 to 1:15	12	1:15 to 1:30	11	Sky brilliantly clear,		
	1:30 to 1:45	15	2:00 to 2:10	14	strong, biting wind.		
	2:15 to 2:30	19	2:45 to 3:00	16			
	3:30 to 3:15	17	3:30 to 3:40	7	Total 111		
Jan. 3	very few, and doubtful				Total 7		

Dr. W. Holt also watched on January 3.
Observations taken at Cape Elizabeth, Portland, Maine.

Perseids, August, 1932

Watch was made on the nights of August 11 and 12, the 10th being cloudy and showery all night. The Perseids were active on August 9, the rate being 10 an hour early in the evening and 30 near midnight when it clouded over.

It was a brilliant shower reaching a climax on the morning of the 12th between 2:00 and 3:00 A.M. when the rate was 34 in 15 minutes and 7 were seen in 1 minute. Special attention was given to head-on meteors and any secondary showers. There were a great number of head-on meteors and showers from Auriga and Aries were good on the night of the 12th. Six Perseids equalled the planet Jupiter and one was equal to the quarter moon. The sky was brilliantly clear and conditions ideal. The tabulated results follow:

Magnitude	6	5	4	3	2	1	0	—1	—2	—3	—4	—5	—6
Aug. 11	19	18	24	43	63	28	47	30	5	6	0	1	1
Aug. 12	2	9	2	26	43	9	15	7	4	1	0	1	0

Total August 11 285 Perseids, 93 trails.
Total August 12 125 Perseids, 35 trails.

410 Perseids, 128 trails.

Colors mostly red and yellow, swift.

Aug. 11 E.S.T.	12(Mdt.)	to	12:30	24	12:30	to	12:45	18
	12:45	to	1:00	21	1:00	to	1:30	35
	1:45	to	2:00	34	2:00	to	2:30	39
	2:30	to	3:00	39	3:00	to	3:30	40
	3:30	to	3:45	35				
Aug. 12	12:45	to	1:00	31	1:00	to	1:30	30
	1:45	to	2:00	29	2:15	to	2:30	21
	2:30	to	3:00	14				

Pegasids, 5; Urs. Min., 4; Andr., 1; Cepheids, 2. Total, 410.

ROBERT M. DOLE.

The Society for Research on Meteorites.—All persons who are interested in forming a Society for Research on Meteorites, of which the purpose shall be to promote the discovery, collection, investigation, and preservation of meteorites, and to advance the science of meteorites and related sciences through the increase and diffusion of knowledge concerning meteorites, are hereby invited to communicate with the Acting Secretary of the preliminary organization, Professor H. H. Nininger, Director, The Nininger Laboratory, 1955 Fairfax St., Denver, Colorado, or with the writer.

By arrangement with the Publishers of POPULAR ASTRONOMY, this journal will serve as the official organ of the new Society. Notices concerning the Society and scientific contributions from its members will appear accordingly in future issues of POPULAR ASTRONOMY.

Other astronomical and scientific periodicals throughout the world are requested to reprint this announcement.

FREDERICK C. LEONARD, Acting President.

Department of Astronomy, University of California,
Los Angeles, 1933 March 18.

The Nature and Significance of Meteorites

The writer has not noted any serious discussion of the probable nature of meteorites in any of the standard publications relating thereto. Perhaps because most astronomers are not suitably acquainted with mineralogy and geology; but these fields are closely concerned with the solving of some problems connected with the essential nature of these strange visitors from outer space.

Opposite page 322 of "Volcanoes," by John W. Judd, published in 1881, in "The International Scientific Series," of D. Appleton & Co., will be found a diagram of the relative acidity and basicity of terrestrial rocks; and with this diagram is given a similar chart of the composition of meteorites; and it will be noted that the meteorites take up the general composition of the surface terrestrial rocks, where they leave off, and carry it on, and in just the way that has followed the most recent discussions of the composition of the deeper parts, and the "core" of the earth. This is most significant, for it would seem to mean that meteorites are things that are made in conditions that resemble the deeper parts of planets like the earth. If this is true, then it would appear that meteorites, the metallic ones in particular, are remnants of the destruction of bodies like planets. This suggests that we are here faced with the possibility that meteorites are fragments of some mighty and long-past cataclysms,—perhaps the destruction of other and earlier planets, of this, or of some other Solar System.

Now it seems that meteorites come from *outer* space. Also it would seem that they were made under conditions of *great heat and pressure.* That might exclude all speculations regarding their *age,* on the "helium basis," for they do

not carry much helium-like material. Also, this would seem to exclude all fancies regarding the possibility of *extra-terrestrial germs* of any form of life.

If this short summary is plausible, it all would seem to open a line of search for the origin of these extra-terrestrial visitors. If the meteorites are from other older planets, what and where were they in the geography and chronology of the outer universe?

The writer does not feel competent to carry on this further, but would submit it to the wiser and more scholarly consideration of the specialists who are quite capable of criticising and testing it, in the broader light of the comparative sciences of both astronomy and geology. But I seriously believe that we have here some rather neglected facts, and some that ought to be considered and discussed with the greatest impartiality. Are we here face to face with some newer and larger suggestions of *other* planets and solar systems that were made and destroyed *before* our present planetary system began its modest course of growth and decay?

CHARLES SKEELE PALMER.

Pittsburgh, Pennsylvania, February 7, 1933.

Comet Notes

By G. VAN BIESBROECK

The various comets that have recently been under observation are all losing in brightness. Only two of them remain fairly accessible in ordinary telescopes: COMET 1932 *g* (GEDDES) and COMET 1933 *a* (PELTIER). The former is passing from the constellation of Bootes into that of Canes Venaticorum in the beginning of April and is therefore visible during the whole night. On the 16th of March it was recorded by the writer as a $10\frac{1}{2}^{M}$ coma with a well condensed nucleus; in spite of the moon the tail was visible in position angle 220° on that night. The brightness falls off slowly and in all probability it will be possible to follow this object through its opposition in April for several months longer. The ephemeris given on p. 118 is quite accurate.

The most recently discovered comet 1933 *a* (PELTIER) has lost rapidly in brightness as was expected from the computed elements. Several orbits have been published: they are based on longer intervals of measures than the first orbit given on p. 166 but the character of the orbit remains unchanged. No ephemeris is at hand for the month of April but by then it will be too faint for telescopes of average size. On April 2 it passes between Betelgeuse and the belt of Orion. The discoverer, L. E. Peltier, sends the following fine series of estimations of the total brightness. The magnitude was determined by comparison with known stars in fields of nearby variables; the stars were thrown out of focus and a selection was made of the star that most nearly matched the comet.

	M		M
1933 Feb. 15	8.6	1933 Feb. 23	8.7
17	8.6	27	9.5
18	8.1	28	9.5
20	8.8	Mar. 16	10.2
21	8.8		

On the last of these days the writer measured the diameter of the coma, which reached about 2′. A small almost stellar nucleus was visible in the center.

At the end of February COMET 1932 *n* (DODWELL) has become extremely diffuse. I estimated at that time the angular diameter of the coma as 7′; further-

more there was hardly any central condensation. Poor weather conditions have not allowed more recent observations here. But the rapidly falling magnitude, which I estimated as 13^M on February 24, makes it doubtful if further observations will be possible.

The record of the behavior of PERIODIC COMET 1925 II (SCHWASSMANN-WACHMANN) is incomplete here in March, but enough observations were secured to make it extremely improbable that there could have been another outburst of activity such as happened in January. The comet was not brighter than 16th magnitude on March 15.

PERIODIC COMET 1932 *I* (FAYE) had dropped to magnitude 15 on March 17 and therefore comes to the end of its period of visibility in the evening sky.

As the season advances several expected periodic comets come in better position and will probably be found before long. COMET PONS-WINNECKE is now less than two months from perihelion passage but has not yet been recovered. The continuation of Crommelin's ephemeris in the *Handbook of the British Astronomical Association* is as follows:

1933 0^h U.T.	Perihelion May 15		Perihelion May 21	
	h m s	°	h m s	° ′
April 3	18 43 28	+5.14	18 14 09	+10 10
9	19 10 46	4.20	18 40 18	9 35
15	19 39 06	3.12	19 07 46	8 42
21	20 07 49	1.54	19 36 30	7 26
27	20 37 10	+0.26	20 05 45	5 53
May 3	21 06 47	−1.09	20 36 12	+ 3 58

The perturbations by Jupiter since the apparition in 1927 have been independently computed by V. Guth, who predicts May 18.997 for the time of perihelion. This differs by only a day from Crommelin's value May 17.707.

In the morning sky two more periodic comets are due before long: COMET GIACOBINI-ZINNER and COMET FINLAY coming to perihelion on 1933 July 16.327 and June 19.8 respectively according to the prediction of the computing section of the British Astronomical Association. The search ephemerides are as follows:

COMET GIACOBINI-ZINNER (by F. R. Cripps).

1933 0^h U.T.	α	δ	Δα	Δδ
	h m	° ′		
March 26	20 09.7	+ 6 47	−1.78	−1.5
April 3	20 31.4	9 0	2.01	1.3
11	20 54.3	11 24	2.16	0.9
19	21 18.9	13 56	2.40	−0.6
27	21 45.2	16 35	2.64	+0.8
May 5	22 13.6	+19 15	2.93	2.7

COMET FINLAY (by P. J. Harris and M. Sumner).

1933 0^h U.T.	α	δ	Δα	Δδ
	h m	° ′		
April 1	21 43.5	−16 14	−2.01	−10.3
9	22 10.9	13 55	2.12	12.1
17	22 39.3	11 16	2.22	13.9
25	23 08.7	8 19	2.30	15.5
May 3	23 39.1	5 05	2.37	16.9
11	0 10.4	− 1 38	2.42	17.7
19	0 42.5	+ 1 56	2.45	18.0
27	1 15.3	5 31	−2.46	−17.7

The last columns show the corrections to be applied for a perihelion date one day later than that assumed.

Williams Bay, Wisconsin, March 23, 1933.

Notes from Amateurs

Astrolab Progress Report

Those interested in this amateur telescope making coöperative movement please refer to the December, January, and February numbers of POPULAR ASTRONOMY. Approximately forty amateurs are devoting some of their spare time to Astrolab's program. The economic conditions limit our United States mailing to 200 copies of the Astroscope per issue, although a number of additional copies go to other countries. Members familiar with other languages are preparing to abstract foreign articles and take care of correspondence not written in English. Several have responded to the plan of forming a parcel post library exchange to responsible parties, and the nucleus of a small astrophysical library has already been formed. Spectroscopic eyepieces of transmission echelon, reflecting echelon, and prismatic types are being designed. While it is too soon to report the results, the response to the "Organization" issue, and the "Eyepiece, Prism, and Diagonal" Committee report have been very gratifying.

Correspondence is invited from those interested in this amateur movement. Please be as specific and complete in your first letter as possible, stating not only what help you want, but also how you can aid the rest of us. A thorough understanding on both sides is very essential for real coöperation and development. Astrolab is a coöperative group, and amateurs writing in should inclose a few stamps to help share expense.

L. I. BUTTLES.

10728 S. Artesian Ave., Chicago, Illinois, March 13, 1933.

Variable Stars

Monthly Report of the American Association of Variable Star Observers for February, 1933

We welcome an original report of observations from Mr. S. Kaho of Sapparo, Japan. Also, after years of silence, a report has been received from Mr. S. C. Hunter of New Rochelle, New York, who is now sojourning at Miami, Florida.

The rapid increase in light of Mira Ceti occurred in about a month and at last reports this variable was at maximum magnitude 3.6. Due to proximity to the sun, the variable cannot now be well observed.

SS Aurigae was at maximum on February 17, twenty-eight days following the previous maximum. The six most recently observed maxima have all been of the narrow type, the last broad type maximum having been observed in May, 1932.

Joseph Meek reports that RY Sagittarii, one of the R Coronae Borealis type variables, has recently decreased two magnitudes. This is of inteerst in view of the fact that this variable has only recently reached maximum brilliancy after a long period of recovery from minimum. The variable decreased very rapidly early in 1931 and remained faint for more than a year.

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1933.

Dec. 0 = J.D. 2427042; Jan. 0 = J.D. 2427073; Feb. 0 = J.D. 2427104.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
V SCL	R AND	X SCL	U AND	Y AND	R ARI
000339	001838	*004435*	010940	013338	021024
044 10.7 Bl	087 9.6 Ah	044 11.1 Bl	043 10.4 Ch	043 13.0 Ch	096 8.9 Jo
051 11.0 Bl	088 9.0 Jo	051 11.2 Bl	062 10.6 Ch	062 13.8 Ch	096 9.2 Sh
060 11.2 Bl	089 9.4 B	060 11.4 Bl	082 11.5 L	094[13.9 L	096 8.7 Pt
068 11.3 Bl	090 9.3 Pt	068 11.6 Bl	089 11.6 B	X CAS	097 9.1 Wd
S SCL	093 9.6 Sh	RR AND	096 11.9 Mg	014958	097 9.1 Hf
001032	093 9.3 Hf	004533	098 11.9 B	074 11.3 Jo	101 8.8 Ah
044 7.7 Bl	093 8.9 Jo	043 9.3 Ch	099 12.4 L	078 11.2 Bn	102 8.8 Ah
051 7.7 Bl	096 8.5 Jo	062 10.0 Ch	125 12.0 El	088 11.0 Jo	103 8.9 L
060 8.3 Bl	096 9.3 Mg	096 12.7 Mg	UZ AND	093 10.4 Jo	104 8.6 Ah
062 8.7 Ht	099 8.8 B	RV CAS	011041	094 11.0 Bn	W AND
068 8.9 Bl	102 7.6 Ad	004746a	043 12.8 Ch	096 10.0 Jo	021143a
090 9.6 Pt	104 7.8 Ko	040 9.0 Ch	062 13.1 Ch	096 10.4 Pt	040 11.4 Ch
X AND	104 8.3 Ah	062 9.5 Ch	088[12.9 Bw	098 11.3 Bn	062 12.0 Ch
001046	105 7.6 Ad	090 11.4 Pt	094 14.5 L	110 10.5 B	066 12.4 Ch
040[13.4 Ch	115 7.4 Ad	098 10.8 B	107[13.1 Bw	U PER	094 13.0 B
066[13.4 Ch	S TUC	— CAS	S PSC	015254	096 13.1 Bw
089 13.7 B	*001862*	004746b	011208	031 8.4 Ch	T PER
096[12.0 Jo	044 11.6 Bl	090 11.1 Pt	083 13.4 L	062 9.9 Ch	021258
096 13.4 Bw	051 12.7 Bl	W CAS	094 13.1 B	074 9.9 Jo	074 8.5 Jo
103 12.8 Bw	062 13.0 Bl	004958	099 13.9 L	075 10.2 Cy	093 8.9 BL
T CET	062 13.2 Ht	043 10.5 Ch	S CAS	093 10.6 BL	094 8.6 Jo
001620	S CET	062 10.0 Ch	011272	094 9.8 Jo	096 8.7 Jo
083 5.7 L	*001909*	074 9.6 Jo	062[13.6 Ch	094 10.5 Ry	096 8.7 BL
T AND	040 11.8 Ch	074 10.3 Ko	096[13.0 Pt	096 9.8 Jo	096 8.4 Pt
001726	062 13.9 Ch	078 9.0 Jo	U PSC	096 10.8 BL	101 8.6 Ah
040 12.8 Ch	090[12.3 Pt	086 10.2 Ko	011712	096 11.0 Pt	107 8.7 BL
062 13.0 Ch	T PHE	088 9.0 Jo	062 13.3 Ch	097 10.7 Ry	127 8.8 El
088[12.6 El	*002546*	089 9.4 B	079 12.2 L	099 10.8 Ry	Z CEP
090[12.6 Pt	044 11.8 Bl	090 9.2 Pt	094 12.1 L	101 11.0 Ry	021281
099[13.7 B	051 12.1 Bl	093 9.7 BL	096 12.5 Mg	107 11.3 BL	032[11.5 Ch
T CAS	062 13.0 Bl	096 9.5 BL	096 12.4 Pt	125 11.3 El	061 12.4 He
001755	062 12.6 Ht	096 8.9 Jo	103 11.8 L	XX PER	096 10.6 Pt
062 11.0 Ch	Y CEP	098 9.2 B	RZ PER	015654	115 11.2 Me
072 10.2 Ch	003179	104 9.5 Ko	012350	031 8.2 Ch	o CET
074 10.2 Jo	059[11.8 Ch	107 9.7 BL	031 9.8 Ch	062 7.8 Ch	*021403*
078 9.3 Jo	U CAS	125 8.9 El	062 9.9 Ch	S ARI	031 9.1 Ch
082 9.6 L	004047a	U TUC	082 9.9 L	015912	046 9.2 Ch
088 9.1 Jo	040[13.9 Ch	*005475*	099 10.4 L	082 11.2 L	062 9.0 Ch
090 10.5 Pt	062[13.3 Ch	044 13.4 Bl	127 12.1 El	099 11.7 L	069 8.9 Ch
092 10.0 Mc	088[12.6 Bw	062[12.9 Ht	R PSC	099 12.5 B	074 8.4 Jo
092 9.1 B	094 13.9 L	Z CET	012502	R ARI	076 9.0 Oy
093 8.9 Jo	116[12.6 Bw	*010102*	031 10.0 Ch	021024	076 8.7 Ah
094 10.0 Mc	RW AND	041 9.1 Ch	062 11.5 Ch	031 12.4 Ch	082 8.4 L
096 9.6 Mc	004132	062 8.9 Ch	096 12.4 Mg	062 10.2 Ch	087 8.5 Ah
096 8.8 Jo	062[13.5 Ch	074 9.2 Ko	096 12.2 Pt	069 10.1 Ch	087 7.5 Ra
099 9.3 L	090[12.6 Pt	079 10.0 L	RU AND	074 9.7 Jo	087 8.6 Cy
104 9.5 Me	V AND	093 9.6 Ko	013238	075 9.8 Ah	088 8.0 Jo
R AND	004435	094 10.7 L	043 10.8 Ch	076 9.6 Ah	091 7.5 Jo
001838	043 9.7 Ch	096 10.8 Pt	062 10.8 Ch	078 9.5 Ah	092 7.7 Cy
036 13.4 Ch	062 10.0 Ch	103 10.8 L	082 10.5 L	079 9.2 L	092 8.6 Hf
062 10.4 Ch	083 11.1 L	U SCL	094 10.8 L	087 9.1 Ah	093 7.0 Jo
069 10.2 Ch	089 11.5 B	*010630*	094 10.7 B	088 9.5 Jo	093 7.9 BL
074 9.7 Jo	098 12.1 B	062 9.7 Bl	095 10.4 Cy	091 9.5 Jo	093 8.0 Sf
074 9.8 Ko	099 12.1 L	068 9.6 Bl	096 10.8 Pt	092 8.9 Hf	094 7.4 Ad
078 9.2 Jo			103 10.7 L	093 8.8 Jo	094 7.4 L
086 9.6 Ko				094 9.0 L	094 7.2 Ra

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1933.

J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

o CET
021403
095 7.7 Oy
095 7.8 Si
096 6.7 Jo
096 7.1 BL
096 7.3 Sh
096 8.0 Si
096 7.4 Wd
096 7.1 Ra
096 6.8 Pt
097 7.2 Hf
097 7.1 Sf
097 7.2 Wd
097 7.0 Ra
098 7.0 Ra
099 6.6 Sf
101 6.2 Sf
101 6.1 Me
101 6.2 Ah
102 6.4 Ah
102 5.9 Sf
103 5.8 L
104 5.9 Ah
105 5.7 Ra
106 5.5 Ra
106 5.0 Ad
106 5.2 Sf
107 5.5 BL
107 4.9 Wa
107 5.4 Ra
108 5.4 Ra
110 5.2 Ra
113 5.0 Ra
115 4.7 Me
115 4.7 Sf
115 4.7 Ad

S PER
021558
074 8.6 Jo
075 9.2 Cy
093 8.9 Sz
093 9.2 BL
094 9.0 Jo
096 9.1 Jo
096 9.4 BL
096 9.0 Pt
101 9.3 Ah
106 9.5 Me
107 9.2 BL
127 9.3 El

R CET
022000
031 8.3 Ch
059 10.6 Ch
079 11.4 L
094 13.1 L
103 12.9 L

RR PER
022150
031 7.8 Ch
062 9.6 Ch
082 10.4 L
096 10.9 Bw
096 11.2 Pt
099 11.3 L
127 12.7 El

R FOR
022426
044 10.8 Bl
051 10.3 Bl
060 10.6 Bl
068 10.5 Bl

U CET
022813
040 12.8 Ch
062 12.6 Ch
083 11.1 L
088 10.5 Hn
090 10.0 B
093 10.4 BL
095 9.9 Hn
096 9.7 Cy
096 10.2 BL
096 10.0 Pt
099 10.0 L
100 9.4 Hn
107 8.8 BL

RR CEP
022980
032[11.6 Ch
061 13.0 He
067 12.1 Ch
096 11.0 Pt
115 10.0 Me

R TRI
023133
031 7.1 Ch
062 6.7 Ch
069 6.6 Ch
073 6.7 Ch
075 6.9 Ah
077 6.4 Oy
078 7.0 Ah
081 7.0 Jo
085 7.0 Ra
086 7.0 Ra
087 7.0 Ra
087 6.9 Je
087 7.0 Ah
088 7.0 Se
088 6.8 Jo
089 6.9 Ra
091 7.1 Se
092 7.4 Je
092 6.8 Hf
093 7.1 Hf
093 6.7 Jo

R TRI
023133
093 6.8 Sh
093 7.6 Sf
094 6.9 Ad
094 7.0 Ra
096 7.0 Jo
096 6.8 Oy
096 7.3 Se
096 6.7 Wd
096 7.1 Ra
096 6.8 Pt
097 7.0 Ra
099 7.3 Se
100 6.8 Hn
100 7.1 Ad
101 7.4 Ah
102 7.4 Je
104 7.3 Ah
105 7.2 Ad
115 7.3 Ad

T ARI
024217
074 10.4 Ko
081 9.8 Jo
086 9.8 Ko
088 9.6 Jo
093 9.4 Jo
096 9.5 Jo
104 9.0 Ko
115 9.3 Me

W PER
024356
040 9.4 Ch
064 9.7 Ch
073 10.0 Ch
074 10.1 Ko
081 9.6 Jo
082 10.1 Ry
086 10.1 Ko
087 10.6 Cy
088 9.5 Jo
093 9.4 Jo
094 10.0 Ry
096 9.5 Pt
096 9.4 Jo
096 10.3 Cy
097 10.0 Ry
099 10.1 Ry
101 10.2 Ry
104 10.2 Me
127 10.1 El

R HOR
025050
044 11.3 Bl
051 11.5 Bl
057 11.9 Sl
060 11.3 Bl
062 12.2 Ht
068 11.9 Bl

T HOR
025751
044 11.7 Bl
051 11.8 Bl
057 11.7 Sl
060 12.3 Bl
062 12.1 Ht

U ARI
030514
096 13.7 Wd
036 13.7 Ch
062 13.7 Ch
094[14.5 L
125[12.5 El

X CET
031401
035 8.8 Ch
057 9.6 Ch
074 10.0 Jo
078 10.3 Jo
079 10.7 L
090 11.4 B
093 11.4 Jo
094 11.4 L
096 11.6 Jo
096 11.2 Pt
103 11.0 L
125 11.8 El

Y PER
032043
031 9.1 Ch
062 8.5 Ch
074 8.2 Ko
075 8.1 Bc
075 8.1 Bf
076 8.1 Bc
076 8.1 Bf
086 8.4 Ko
087 8.9 Ah
088 8.0 Jo
093 8.1 Jo
093 8.5 BL
096 8.4 BL
096 8.4 Sq
096 8.0 Pt
096 8.3 Jo
101 9.1 Ah
107 8.5 BL
113 9.4 Me
115 9.0 Sq
127 9.5 El

R PER
032335
040 8.9 Ch
062 8.6 Ch
074 8.8 Jo
083 9.5 L
088 9.0 Jo
093 9.2 Jo
095 9.3 Ma
096 9.3 Pt

R PER
032335
096 9.4 Jo
099 10.4 L
104 10.2 Mg
127 12.2 El

NOV PER
032443
096 13.3 Pt

T FOR
032528
079 8.6 L
099 8.7 L
104 8.9 L

U ERI
034625
116[12.6 Me

T ERI
035124
116 11.9 Me

W ERI
040725
104 8.5 Me

R TAU
042209
036[13.0 Ch
065[13.9 Ch
095 13.2 Ma
096 13.2 Pt

W TAU
042215
036 10.8 Ch
065 12.4 Ch
074 11.5 Jo
078 11.6 Jo
083 12.1 L
088 11.8 El
092 12.0 Cy
093 11.8 Jo
096 11.8 Jo
096 11.2 Pt
099 11.8 L
102 11.5 Cy
104 11.4 Me
116 11.2 Bw
119 10.8 El

S TAU
042309
036 13.0 Ch
065 13.9 Ch
096[13.0 Pt

T CAM
043065
096 11.1 BL
096 11.7 Jo
096 11.2 Pt
099 11.0 L
107 11.5 BL
119 12.2 El

RX TAU
043208
036 13.6 Ch
065 13.8 Ch
094 12.7 L
096 13.1 Bw
096 13.0 Pt
103 12.8 Bw
104 12.7 L
119 12.5 El

R RET
043263
044 12.5 Bl
057 12.6 Sl
062 12.5 Ht
062 12.8 Bl

X CAM
043274
038 11.2 Ch
058 12.4 Ch
063 12.2 Ch
069 11.8 Ch
083 10.3 L
096 8.6 Cy
096 8.6 Pt
099 8.3 L
104 8.2 Me
127 8.0 El

R DOR
043562
044 5.6 Bl
051 5.7 Bl
057 5.7 Sl
060 6.0 Bl
062 5.8 Ht
068 5.6 Bl

R CAE
043738
044 8.5 Bl
051 8.7 Bl
055 9.3 Ht
060 8.8 Bl
062 9.2 Ht
068 9.1 Bl

R PIC
044349
044 8.5 Bl
051 8.4 Bl
055 8.8 Ht
060 7.9 Bl

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1933.

J.D.Est.	Obs.	J.D.Est.	Obs.	J.D.Est.	Obs.	J.D.Est.	Obs.	J.D.Est.	Obs.	J.D.Est.	Obs.
R PIC		R LEP		R AUR		W AUR		T ORI		RR TAU	
044349		*045514*		050953		052036		*053005a*		053326	
062	8.7 Ht	099	7.4 L	096	8.7 Pt	096	13.4 El	099	11.0 Me	104	11.5 Ko
068	8.4 Bl	100	7.3 Hn	096	9.8 Jo	099	13.9 L	101	11.0 Me	104	11.9 Me
V TAU		102	7.8 Je	100	7.6 Ad	104[	13.2 Mg	101	10.9 Pt	105	11.8 Pt
044617		103	7.8 Je	104	8.3 Ah	119[	13.2 El	102	10.4 Me	113	12.1 Me
036	13.8 Ch	104	8.6 Mg	104	8.0 Me	S ORI		103	10.4 L	115	11.6 Me
065	13.8 Ch	104	7.0 Ko	105	7.5 Ad	*052404*		104	10.3 L	116	12.0 Me
094	12.5 Jo	105	7.8 Ra	115	7.5 Ad	036	10.1 Ch	104	10.0 Me	RU AUR	
096	12.3 Jo	110	7.9 Ra	T PIC		043	10.2 Ch	104	10.0 Ko	053337	
096	12.5 Pt	113	8.0 Ra	*051247*		061	10.1 Ch	105	10.3 Pt	036	13.5 Ch
104	12.4 Mg	113	7.5 Me	044	8.2 Bl	065	10.0 Ch	113	9.7 Me	096	11.1 Pt
104	12.4 Me	V ORI		051	8.3 Bl	074	10.3 Jo	115	9.9 Me	104	10.3 Mg
116	11.7 Me	050003		055	8.7 Ht	078	10.2 Jo	116	9.7 Me	116	10.6 Me
119	11.8 El	032	10.4 Ch	060	8.7 Bl	088	10.4 Jo	122	9.4 Ma	117	9.9 Bw
R ORI		059	9.1 Ch	062	8.9 Ht	088	10.6 El	AN ORI		119	10.0 El
045307		074	9.2 Jo	068	9.5 Bl	094	10.5 Jo	*053005f*		U AUR	
032	9.5 Ch	078	9.1 Jo	T COL		095	11.2 Ma	122	11.4 Ma	053531	
059	9.6 Ch	083	9.5 L	*051533*		095	11.1 Mg	S CAM		036[	13.7 Ch
083	9.6 L	088	9.5 Jo	044	7.1 Bl	096	10.6 Pt	053068		061[	13.7 Ch
093	9.9 Sf	093	9.6 Jo	051	7.4 Bl	096	10.4 Jo	032	8.6 Ch	094	13.7 L
096	9.4 Cy	094	11.1 B	055	7.8 Ht	097	10.3 B	059	9.3 Ch	SU TAU	
097	9.9 B	096	10.0 Jo	060	8.2 Bl	104	11.0 Me	074	8.7 Jo	054319	
099	10.0 L	096	9.6 Pt	062	8.0 Ht	122	11.3 Ma	078	8.5 Jo	019	9.7 Ch
103	10.0 Mg	099	9.7 L	068	8.2 Bl	125	11.6 El	093	8.7 Jo	033	9.7 Ch
104	10.5 Me	104	10.2 Me	S AUR		T ORI		093	9.5 BL	058	9.7 Ch
R LEP		104	10.4 Mg	052034		*053005a*		096	8.8 Jo	061	9.7 Ch
045514		T LEP		031	9.4 Ch	036	10.0 Ch	096	9.6 BL	069	9.7 Ch
031	9.3 Ch	*050022*		036	9.3 Ch	043	10.1 Ch	096	9.3 Pt	074	9.5 Ko
053	9.1 Ch	044	10.3 Bl	048	9.6 Ch	061	9.9 Ch	107	10.0 BL	074	9.5 L
057	7.2 Sl	051	9.5 Bl	058	9.3 Ch	072	10.4 Ch	127	9.8 El	079	9.5 L
063	7.0 Sl	060	9.1 Bl	061	9.0 Ch	074	10.5 Jo	RR TAU		082	9.6 L
065	8.6 Ch	068	8.5 Bl	065	8.8 Ch	074	10.6 Ko	053326		083	9.5 L
069	8.8 Je	074	8.2 Jo	071	8.9 Ch	074	10.4 L	074	12.0 Ko	084	9.6 L
074	7.5 Jo	074	8.2 Ko	074	8.7 Jo	078	10.3 Jo	074	10.6 L	085	9.5 L
074	7.2 Ko	078	8.0 Jo	074	8.5 Ko	079	10.2 L	079	11.9 L	086	9.5 L
076	7.3 Bc	086	8.0 Ko	078	8.7 Jo	082	10.2 L	083	11.7 L	086	9.5 Pt
076	7.3 Bf	088	7.8 Jo	086	8.6 Ko	083	10.2 L	084	11.2 L	086	9.5 Ko
078	7.4 Jo	091	7.8 Jo	088	9.1 Jo	084	10.2 L	085	11.0 L	087	9.7 Pt
083	7.6 L	094	7.7 Jo	090	9.1 B	085	10.3 L	086	11.3 L	088	9.3 Jo
086	7.1 Ko	096	7.8 Jo	091	8.5 Jo	086	10.3 L	086	11.7 Pt	088	9.5 Ko
087	8.6 Je	096	7.8 Pt	091	9.0 Mc	086	10.5 Pt	087	11.8 Pt	090	9.6 Pt
087	7.8 Ra	101	7.8 Wa	093	8.7 Jo	086	10.2 Ko	088	11.9 Pt	091	9.4 Jo
088	7.3 Jo	104	8.0 Me	093	9.0 BL	087	10.5 Pt	088	11.9 Ko	092	9.6 Cy
091	7.3 Jo	104	7.9 Ko	094	8.8 Mc	087	9.9 Cy	090	11.9 Pt	092	9.5 B
091	8.5 Wd	S PIC		096	8.7 Mc	088	10.6 Jo	092	11.6 Cy	093	9.5 Ko
091	8.7 Hf	*050848*		096	8.4 Jo	088	10.2 Ko	092	11.5 B	093	9.4 L
092	8.5 Je	062[	13.4 Bl	096	8.9 BL	088	10.5 Pt	093	11.4 Ko	094	9.4 L
093	8.6 Hf	R AUR		096	9.1 El	090	10.5 Pt	093	11.6 L	094	9.3 Jo
093	8.4 Sh	050953		096	8.3 Pt	091	10.3 Jo	094	10.9 L	095	9.6 Ma
094	7.7 Ra	033	10.8 Ch	104	9.6 Me	092	10.3 Cy	096	11.8 Pt	096	9.8 Cy
094	7.2 Jo	061	10.6 Ch	107	8.5 BL	093	10.5 Ko	097	11.3 Cy	096	9.2 Jo
094	8.1 B	074	10.6 Jo	119	9.0 El	093	10.2 L	097	11.7 Pt	096	9.6 Pt
095	8.7 Oy	077	10.0 Je	W AUR		094	10.6 Jo	099	10.5 L	097	9.6 Pt
096	6.8 Jo	078	10.6 Jo	052036		094	10.1 L	099	10.9 Me	099	9.5 L
096	7.2 Pt	087	10.3 Ah	036	11.5 Ch	096	10.6 Jo	101	11.4 Me	101	9.8 Pt
096	8.3 Sh	088	10.0 Jo	061	12.6 Ch	096	10.4 Pt	101	11.5 Pt	101	9.6 Me
097	8.5 Hf	091	9.9 Jo	090	13.5 B	097	10.4 Pt	102	11.8 Me	102	9.6 Me
097	8.5 Wd	093	9.5 Jo	095	13.2 Ma	097	10.8 B	103	11.2 L	103	9.5 L
097	7.8 Ra	093	8.8 Je	096	13.3 Pt	099	10.5 L	104	11.0 L	104	9.5 L

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1933.

J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

SU TAU
054319
104 9.6 Me
104 9.6 Ko
105 9.5 Pt
113 9.5 Me
115 9.6 Me
116 9.6 Me
119 9.6 El
122 9.5 Ma

S COL
054331
062[13.5 Bl

Z TAU
054615a
036 13.3 Ch
065 11.4 Ch
083 10.1 L
095 10.5 Ma
099 10.4 L
102 10.5 Cy
116 10.8 Me
122 10.4 Ma

RU TAU
054615c
036 13.0 Ch
065 12.8 Ch
095 11.2 Ma
099 11.6 L
102 11.0 Cy
116 11.3 Me
122 11.1 Ma

R COL
054620
044 13.3 Bl
062 13.3 Bl

U ORI
054920a
031 7.0 Ch
038 6.6 Ch
053 7.0 Ch
059 7.1 Ch
069 7.1 Ch
074 6.8 Jo
075 7.6 Ah
076 7.6 Ah
076 7.8 Oy
077 7.9 Je
078 7.7 Ah
085 8.4 Ra
086 7.5 Sq
087 7.8 Ah
087 8.0 Je
088 7.5 Jo
090 8.7 Ra
091 7.6 Jo
091 7.9 Mc
092 8.3 Je
092 8.4 Hf
093 8.4 Hf
093 8.3 Sh
094 7.8 Jo
094 8.4 Mc
094 7.4 Ad
094 8.1 B
095 8.7 Oy
096 7.7 Jo
096 8.2 Mc
096 8.4 Sq
096 8.3 Wd
096 7.2 Pt
097 8.7 Ra
097 7.9 Wa
100 7.6 Ad
101 8.6 Ah
102 7.7 Hn
102 8.7 Ra
103 8.9 Je
108 8.2 Ad
110 8.7 Ra
113 9.0 Ra
113 8.4 Me

UW ORI
054920b
096 11.4 Wd

V CAM
054974
059[12.2 Ch
094[13.9 L
116[13.6 Me

Z AUR
055353
074 10.6 Jo
078 10.5 Jo
087 10.8 Pt
088 10.2 Jo
090 10.8 Pt
091 9.8 Jo
092 9.9 B
093 9.8 Jo
094 10.8 Mc
096 10.0 Cy
096 10.1 Pt
097 9.8 Jo
104 10.6 Me
105 10.2 Pt
107 10.3 Pt
127 10.8 El

R OCT
055686
044 9.1 Bl
051 9.6 Bl
058 9.7 Sl
060 9.7 Bl
062 10.1 Ht
068 10.0 Bl

X AUR
060450
031 8.8 Ch
036 8.8 Ch
047 8.5 Ch
059 8.7 Ch
071 8.9 Ch
079 9.6 L
093 10.5 Sf
094 11.1 L
094 10.5 B
096 10.3 Pt
103 11.4 L

V AUR
061647
043 12.5 Ch
061 12.2 Ch
083 11.1 L
092 11.3 El
092 10.8 B
099 10.7 L
104 10.9 Me
119 10.6 El
127 10.9 El

V MON
061702
043 13.0 Ch
061 13.4 Ch
095 13.5 Mg
101 12.0 Wa

AG AUR
062047
079 9.5 L
094 10.2 L
103 9.8 L

U LYN
063159
127[13.8 El

R MON
063308
043 12.8 Ch
065 12.7 Ch
088 10.9 Jo
091 11.0 Jo
094 10.6 Jo
099 11.7 B
103 11.6 Mg

NOV PIC
063462
062 8.7 Ht

S LYN
063558
043[13.8 Ch
065[13.7 Ch
092 13.4 El
094 13.1 L
096 12.9 Ry
096 13.0 Pt
097 13.1 B
103 12.9 L

S LYN
063558
121 11.3 El

X GEM
064030
078 10.7 Bn
090 10.2 B
094 9.9 Bn
095 10.3 Ma
097 10.2 Cy
097 9.9 Jo
098 9.8 Bn
103 9.2 Bn
104 10.2 Mg
122 9.2 Ma

Y MON
065111
043 8.8 Ch
059 9.0 Ch
078 9.1 Jo
082 9.5 L
092 10.3 B
095 11.0 Ma
096 10.3 Pt
097 11.2 Jo
099 10.9 L
104 11.4 Mg
122 13.5 Ma

X MON
065208
078 8.4 Jo
079 8.5 L
088 8.9 Jo
091 9.3 Jo
094 9.3 Jo
094 9.2 L
095 8.7 Si
096 9.2 Jo
100 9.0 Hn
103 9.1 L

R LYN
065355
043 8.2 Ch
072 9.9 Ch
083 9.9 L
087 10.6 Ah
092 10.4 El
095 10.6 Ma
101 11.0 B
102 11.2 Hn
103 10.7 L
121 11.7 El
122 11.6 Ma

RS GEM
065530
074 10.0 Jo
078 9.8 Jo
081 10.0 Jo
091 11.0 Ma
096 10.3 Pt
097 11.2 Jo
099 10.9 L
104 11.4 Mg
122 13.5 Ma

RS GEM
065530
074 10.0 Jo
092 12.4 Wd
096 12.5 Wd
104 12.5 Wd
105 12.5 Pt

Z GEM
070122b
078 9.8 Jo
081 10.0 Jo
091 10.1 Jo
094 10.1 Jo

RS GEM
065530
095 10.6 Ma
096 10.0 Jo
099 10.4 Me
105 10.3 Pt
122 11.1 Ma

Z CMA
065911
058 9.7 Sl

V CMI
070109
059 11.2 Ch
065 11.7 Ch
092 13.0 B
094 13.4 L
097 13.2 Bw
103 13.3 Bw
103 13.2 L
105 12.8 Pt

R GEM
070122a
043 7.2 Ch
053 7.1 Ch
064 7.0 Ch
072 7.1 Ch
074 7.0 Ch
075 7.3 Ah
076 7.3 Ah
077 7.5 Je
078 7.4 Ah
078 7.0 Jo
081 7.4 Jo
087 7.4 Ah
087 7.5 Je
090 7.5 Ra
091 7.3 Jo
091 7.5 Hf
091 7.4 Wd
094 7.3 Jo
094 7.1 Ad
094 7.5 Ra
096 7.5 Ra
096 7.4 Jo
096 7.2 Wd
097 7.5 Ra
098 7.5 Ra
101 7.5 Ah
103 7.5 Je
104 7.5 Ah
104 7.8 Sh
104 7.6 Wd
105 7.1 Pt
106 7.3 Ad

S GEM
073173
044[13.2 Bl
062 13.6 Bl

TW GEM
070122c
105 8.2 Pt

R CMI
070310
059 10.4 Ch
065 9.8 Ch
074 9.1 Jo
078 9.3 Jo
081 8.9 Jo
091 9.0 Jo
091 9.6 Hf
091 9.5 Wd
092 9.7 L
094 8.9 Jo
095 9.4 Oy
096 8.8 Jo
099 8.8 L
105 8.8 Pt

R VOL
070773
062[13.4 Ht

L_2 PUP
071044
051 4.2 Sl
057 4.3 Sl
063 4.2 Sl

RR MON
071201
061[13.4 Ch
099[14.2 L
109[12.4 Bw

V GEM
071713
061 11.6 Ch
092 13.7 El
099 14.2 L
105 13.4 Pt

S CMI
072708
060 11.9 Ch
066 12.0 Ch
088 12.5 Jo
094 12.7 Jo
096 12.8 Jo
099 12.4 B
105 12.0 Pt

T CMI
072811
061[13.4 Ch
092 12.2 B
105 11.6 Pt

S VOL
073173
044[13.2 Bl
062 13.6 Bl

U CMI
073508
061 9.9 Ch

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1933.

J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

U CMi
073508
074 9.3 Jo
078 8.8 Jo
079 9.1 Cy
079 9.6 L
088 8.8 Jo
091 8.8 Jo
092 8.9 Cy
094 9.2 Jo
094 9.1 L
096 8.8 Jo
098 8.7 B
099 8.7 B
103 8.8 L
105 8.5 Pt

S GEM
073723
036[13.6 Ch
091 12.0 Jo
092 13.8 El
097 11.5 Jo
121 12.3 El

W PUP
074241
044 10.5 Bl
051 11.1 Bl
060 11.7 Bl
062 12.0 Ht
068 11.9 Bl

T GEM
074323
036[13.1 Ch
066[13.1 Ch
092 13.7 B
092 13.5 El
095 13.2 Ma
097 13.1 Bw
105 12.3 Pt
121 10.6 El
122 10.5 Ma
127 10.5 El

U PUP
075612
065 10.3 Ch
088 8.3 Jo
093 8.4 Jo
096 8.4 Jo
101 8.5 B
109 9.5 Bw

R CNC
081112
046 11.2 Ch
065 10.8 Ch
071 11.0 Jo
078 10.8 Jo
088 10.5 Jo
091 10.3 Jo
092 10.7 Cy
096 10.0 Jo

R CNC
081112
096 10.6 Sh
097 10.6 Wd
097 10.5 Hf
101 10.3 B
104 10.5 Ah
105 10.3 Pt

V CNC
081617
065 12.7 Ch
092 10.3 Cy
094 10.2 L
101 9.6 B
102 9.8 Cy
103 9.5 L
104 9.7 Ah
105 9.4 Pt

RT HYA
082405
079 8.0 L
086 8.3 Ko
091 8.3 Jo
092 8.6 El
093 8.4 Jo
096 8.4 Jo
099 8.6 L
105 8.0 Pt
125 8.3 El

R CHA
082476
044 11.4 Bl
051 11.6 Bl
058 12.0 Sl
060 12.2 Bl
062 12.1 Ht

U CNC
083019
065 13.8 Ch
092 13.7 El
125 13.9 El
127 14.0 El

X UMA
083350
092 13.7 El
101[13.8 B
105[12.5 Pt
121[13.5 El

S HYA
084803
046 7.8 Ch
065 7.6 Ch
069 7.7 Ch
075 8.1 Ah
091 8.6 Jo
092 8.8 El
093 8.8 Jo
096 8.9 Jo
101 10.0 B
105 9.8 Pt

S HYA
084803
125 10.8 El

T HYA
085008
046 10.8 Ch
065 11.9 Ch
099 12.4 L
101 12.0 B
102 12.6 Cy

T CNC
085120
064 9.0 Ch
074 8.2 Jo
088 8.0 Jo
091 8.0 Jo
092 8.3 Cy
093 8.3 BL
094 8.3 Jo
096 8.2 Jo
096 8.5 BL
105 7.9 Pt
107 8.7 BL

T PYX
090031
044 [t Bl

V UMA
090151
074 10.1 Jo
078 10.1 Jo
082 10.3 L
088 10.0 Jo
091 10.2 Jo
092 10.6 Mc
093 10.5 Mc
093 10.2 Sf
094 10.1 Jo
095 10.7 L
096 9.7 Jo
096 10.7 Mc
096 10.5 El
103 10.5 L
121 10.3 El
125 9.9 El

W CNC
090425
065 11.6 Ch
083 11.7 L
095 12.5 L
103 12.6 L
105 12.3 Pt

RW CAR
091868
044 11.7 Bl
051 11.0 Bl
060 10.6 Bl
062 10.4 Ht
068 10.4 Bl

Y VEL
092551
062 13.4 Bl
068 13.5 Bl

R CAR
092962
044 9.6 Bl
051 9.4 Bl
051 9.1 Sl
058 9.1 Sl
060 9.1 Bl
062 9.3 Ht
068 9.0 Bl

X HYA
093014
046 11.4 Ch
102 12.7 Cy

Y DRA
093178
046[11.3 Ch
067[12.0 Ch
094 14.4 L
096 14.2 El
127[14.0 El

R LMI
093934
046 12.1 Ch
064 12.3 Ch
088 11.5 Jo
096 10.5 Jo
105 12.2 Pt

R LEO
094211
019 8.9 Ch
063 5.8 Ch
067 6.0 Ch
074 5.7 Jo
075 5.9 Ah
076 6.0 Oy
077 5.9 Oy
078 5.9 Ah
078 5.8 Jo
081 6.1 Jo
091 6.1 Jo
091 6.3 Mc
092 6.5 Hf
092 6.0 Se
093 6.4 Sh
093 6.4 Mc
093 6.1 Sz
093 6.4 Hf
094 6.0 Jo
094 6.5 Mc
094 5.9 Ad
095 6.6 Mc
095 6.2 Oy
095 6.0 Si
095 6.2 Ma
096 6.2 Jo
096 6.0 Se

R LEO
094211
096 6.6 Wd
099 6.1 Se
100 6.2 Ad
101 6.1 Ah
101 5.8 Pt
102 6.0 Hn
102 6.2 Ah
103 6.7 Wd
104 6.2 Ah
105 6.4 Me
106 6.4 Ad
106 6.6 Sh
115 6.7 Ad

1 CAR
094262
051 3.5 Sl
058 3.4 Sl

Y HYA
094622
101 6.5 Pt

Z VEL
094953
044 12.5 Bl
051 12.7 Bl
058 12.6 Sl
060 12.4 Bl
062 13.0 Ht
068 12.4 Bl

V LEO
095421
046 12.4 Ch
064 11.5 Ch
074 10.2 Jo
078 9.9 Jo
088 9.1 Jo
092 9.4 Cy
093 8.8 Jo
095 9.1 Ma
096 9.2 El
096 8.7 Jo
101 8.3 Pt
121 9.1 El
125 9.1 El

RR CAR
095458
062 8.0 Ht

RV CAR
095563
062[13.1 Ht

S CAR
100661
044 6.2 Bl
051 6.3 Bl
051 6.4 Sl
058 6.5 Sl
060 6.8 Bl
062 6.8 Ht
068 7.4 Bl

U UMA
100860
045 6.5 Ch
067 6.6 Ch

Z CAR
101058a
062 12.2 Ht
062 12.1 Bl
068 11.6 Bl

W VEL
101153
044 13.0 Bl
062 12.8 Bl

U HYA
103212
014 5.7 Ka
042 5.5 Ka
045 5.3 Ch
067 5.6 Ch
069 5.7 Ka
070 5.8 Ka
095 6.2 Ka

RZ CAR
103270
062 10.8 Ht

R UMA
103769
064 12.1 Ch
072 11.7 Ch
074 11.5 Jo
078 10.9 Jo
091 10.7 Jo
091 11.1 Hf
091 11.0 Wd
092 10.9 Wd
092 10.7 Cy
094 10.5 Jo
096 10.6 Jo
096 10.7 El
096 9.7 Sh
096 10.8 Wd
097 10.8 Wd
097 10.8 Hf
101 10.3 Pt
104 9.7 Wd
104 9.8 Sh
117 8.5 Wd
121 8.1 El
125 8.0 El

V HYA
104620
019 7.8 Ch
044 7.4 Bl
045 7.8 Ch
067 8.1 Ch
068 7.6 Bl
082 7.2 L
094 7.3 L
101 7.1 Pt
103 7.3 L

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1933.

J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

RS HYA
104628
044 12.3 Bl
068 10.3 Bl
W LEO
104814
046 12.2 Ch
083 12.7 L
095 12.9 L
095 12.9 Ma
096 12.9 El
101 12.7 Pt
103 12.7 L
106 13.1 El
121 13.0 El
125 13.1 El
S LEO
110506
046 11.2 Ch
079 11.0 L
092 11.1 Cy
093 10.3 Jo
094 11.5 L
095 10.6 Ma
096 11.5 El
101 11.6 Pt
103 12.0 L
106 11.8 El
121 12.4 El
125 12.9 El
RY CAR
111561
044 12.7 Bl
051 12.8 Bl
060 12.9 Bl
062 12.9 Ht
RS CEN
111661
044 9.8 Bl
051 10.1 Bl
060 10.8 Bl
062 11.4 Ht
068 11.9 Bl
X CEN
114441
044[12.2 Bl
062[13.1 Ht
AD CEN
114858
062 9.5 Ht
W CEN
115058
044 9.0 Bl
051 8.2 Bl
060 8.3 Bl
062 8.3 Ht
068 8.2 Bl
R COM
115919
046[12.2 Ch

SU VIR
120012
082 8.8 L
092 8.6 Cy
093 8.7 Jo
095 9.0 L
095 9.2 Ma
096 8.6 Jo
096 9.4 El
101 9.3 Pt
103 8.8 L
106 9.8 El
121 10.5 El
123 10.4 El
T VIR
120905
082 10.7 L
095 11.1 L
101 11.8 Pt
103 11.6 L
R CRV
121418
051 13.7 Sl
083 12.7 L
094 13.5 L
103 13.7 L
SS VIR
122001
079 8.1 L
093 8.0 Jo
094 8.4 L
096 7.9 Jo
096 8.4 El
103 8.0 L
121 8.4 El
123 8.1 El
T CVN
122532
045 9.9 Ch
068 9.8 Ch
093 9.8 Jo
095 10.3 Cy
096 9.8 Jo
101 10.2 Pt
102 10.7 Cy
Y VIR
122803
082 12.4 L
095 12.9 L
103 13.3 L
U CEN
122854
044 11.9 Bl
062[12.3 Ht
T UMA
123160
072 12.8 Ch
088 11.7 Jo
092 11.6 Hn
093 11.0 Jo

T UMA
123160
095 11.7 Ma
096 10.9 Jo
096 11.2 El
096 11.1 Wd
097 11.3 Wd
097 11.3 Hf
101 10.9 Ah
101 10.8 Pt
104 10.7 Sh
104 10.8 Wd
117 8.8 Wd
121 8.6 El
123 8.4 El
R VIR
123307
045 10.3 Ch
069 11.0 Ch
093 9.0 Jo
095 9.1 Ma
096 8.8 Jo
101 8.2 Pt
102 8.4 Ah
106 7.5 Me
RS UMA
123459
045 10.1 Ch
068 9.8 Ch
072 9.8 Ch
074 8.8 Jo
075 9.1 Ah
076 9.1 Ah
078 9.3 Ah
078 9.0 Jo
078 9.3 Bn
087 9.5 Ah
088 9.3 Jo
091 9.6 Jo
091 9.3 Hf
091 9.7 Wd
092 9.8 Hn
093 9.6 Jo
093 10.0 Cy
094 9.4 Bn
094 9.3 Ry
095 10.2 Ma
096 9.2 El
096 9.8 Sh
096 9.8 Wd
097 9.8 Wd
097 9.7 Hf
098 9.8 Bn
098 9.3 Ry
101 10.2 Ah
101 10.0 Pt
102 10.2 Cy
103 10.3 Bn
103 9.9 Wd
104 9.9 Wd

RS UMA
123459
104 10.0 Sh
117 10.6 Wd
121 10.5 El
123 10.9 El
S UMA
123961
045 8.7 Ch
068 9.8 Ch
069 10.2 Ch
072 10.4 Ch
074 9.7 Jo
075 9.7 Ah
076 9.8 Ah
078 9.9 Ah
078 10.1 Jo
087 10.3 Ah
088 10.3 Jo
091 10.5 Jo
091 10.3 Hf
091 10.3 Wd
092 10.5 Hn
093 11.0 Mc
094 10.3 Jo
095 10.8 Ma
096 10.6 Jo
096 10.4 El
096 10.8 Sh
096 10.9 Wd
097 10.7 Wd
097 10.6 Hf
101 10.8 Ah
101 10.3 Pt
104 10.6 Wd
121 11.3 El
123 11.4 El
RU VIR
124204
094 13.9 L
096 13.7 El
103 14.0 L
121 13.4 El
123 13.8 El
U VIR
124606
082 12.9 L
094 12.0 L
103 11.4 L
RV VIR
130212
069 11.0 Ch
079 11.7 L
094 12.5 L
103 13.0 L
U OCT
131283
044 8.5 Bl
051 8.6 Bl
062 9.1 Bl

U OCT
131283
062 9.2 Ht
068 9.1 Bl
V CVN
131546
100 7.5 Th
106 7.8 GD
V VIR
132202
094[13.2 L
R HYA
132422
045 8.2 Ch
065 7.7 Ch
069 7.8 Ch
082 6.9 L
095 6.8 L
103 6.8 L
S VIR
132706
045 9.9 Ch
065 10.5 Ch
069 10.7 Ch
RV CEN
133155
044 8.5 Bl
051 7.8 Bl
068 8.0 Bl
T UMI
133273
083 9.7 L
093 10.2 Cy
093 9.6 Jo
096 9.8 Jo
096 10.2 El
099 10.4 L
RU VIR
124204
121 11.6 El
123 11.3 El
T CEN
133633
051 6.1 Sl
R CVN
134440
045 8.5 Ch
068 7.8 Ch
078 7.6 Ah
088 7.8 Jo
093 7.8 Jo
095 8.2 Oy
096 7.7 Jo
101 8.4 Ah
102 8.4 Ah
T APS
134677
044 7.5 Bl
051 7.1 Bl
068 8.0 Bl
U UMI
141567
075 9.0 Ah
076 8.9 Ah
078 9.0 Ah
081 9.0 Jo
087 8.8 Ah
088 8.4 Jo
093 8.5 Jo
093 8.4 Cy
096 8.1 Jo
096 8.7 El
101 8.6 Ah
104 8.5 Ah
107 8.2 Pt
121 7.9 El
125 8.1 El
S BOO
141954
019 10.3 Ch
065 8.2 Ch
074 8.5 Jo
083 8.3 L
088 8.7 Jo
093 8.4 Jo
096 8.1 Jo
097 8.7 Th
098 8.6 Th
099 8.7 Th
099 8.2 L
107 8.8 Pt
RS VIR
142205
082 10.6 L
095 10.8 L
095 11.4 Cy
103 10.5 L
V BOO
142539a
039 7.5 Ch
065 7.8 Ch

T APS
134677
068 12.5 Bl
Z BOO
140113
083 12.9 L
095 13.7 L
096 13.3 El
105 13.7 L
121 13.7 El
123 13.7 El
Z VIR
140512
103 14.6 L
R CEN
140959
044 7.3 Bl
051 7.1 Bl
068 8.0 Bl
U UMI
141567
075 9.0 Ah
076 8.9 Ah
078 9.0 Ah
081 9.0 Jo
087 8.8 Ah
088 8.4 Jo
093 8.5 Jo
093 8.4 Cy
096 8.1 Jo
096 8.7 El
101 8.6 Ah
104 8.5 Ah
107 8.2 Pt
121 7.9 El
125 8.1 El
S BOO
141954
019 10.3 Ch
065 8.2 Ch
074 8.5 Jo
083 8.3 L
088 8.7 Jo
093 8.4 Jo
096 8.1 Jo
097 8.7 Th
098 8.6 Th
099 8.7 Th
099 8.2 L
107 8.8 Pt
RS VIR
142205
082 10.6 L
095 10.8 L
095 11.4 Cy
103 10.5 L
V BOO
142539a
039 7.5 Ch
065 7.8 Ch

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1933.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
V Boo			Y Lib			S UMi			V CrB			R Sco			R UMi		
142539a			*150605*			153378			154639			*161122a*			163172		
060	7.9	Ch	079	14.1	L	099	10.9	Me	095	9.6	Cy	107[12.4		Pt	096	9.4	Jo
074	8.2	Cy	103	14.2	L	107	10.3	Pt	097	8.5	Jo	S Sco			099	9.5	L
078	8.2	Ah	S Lib			U Lib			102	9.6	Ah	*161122b*			R Dra		
088	8.4	Jo	*151520*			*153620a*			106	10.0	Me	107[12.4		Pt	163266		
092	8.1	Cy	068	8.4	Ch	106	9.7	Me	107	8.7	Pt	W CrB			028	8.3	Ch
093	8.6	Jo	079	8.4	L	R CrB			R Lib			161138			045	7.7	Ch
095	8.9	Oy	094	8.5	L	154428			*154715*			107	12.5	Pt	072	7.9	Ch
096	8.7	Jo	103	8.6	L	040	6.4	Ch	079[13.5		L	W Oph			074	8.3	Jo
099	9.0	Me	106	8.9	Me	065	6.0	Ch	103	13.1	L	*161607*			075	8.2	Ah
101	8.7	Ah	107	8.9	Pt	068	6.0	Ch	RR Lib			083	11.4	L	076	8.3	Ah
102	8.9	Cy	S Ser			079	6.0	Cy	*155018*			099	9.7	L	078	8.4	Ah
107	9.4	Pt	151714			079	6.0	L	079	12.4	L	107	9.7	Pt	087	8.7	Ah
[illegible]		Cam	068	10.5	Ch	082	6.0	L	099	11.3	L	V Oph			088	8.6	Jo
[illegible]		2584	082	10.7	L	083	6.0	L	106	10.2	Me	*162112*			091	8.7	Jo
032	8.4	Ch	095	11.7	Cv	087	5.9	Ra	107	9.8	Pt	082	9.4	L	096	9.3	Jo
059	9.0	Ch	096	11.7	El	090	6.0	Cy	Z CrB			103	8.8	L	096	9.1	Wd
072	9.5	Ch	099	11.7	L	091	5.9	Ra	155229			107	8.7	Pt	099	9.8	Me
093	0.0	Cy	107	12.1	Pt	092	6.0	Cy	099	14.5	L	U Her			101	9.4	Ah
[illegible]		Boo	121	12.3	El	092	6.0	L	RZ Sco			162119			102	9.5	Ah
143227			125	12.1	El	093	5.8	Jo	*155823*			066	10.6	Ch	104	10.0	Wd
039	9.4	Ch	S CrB			094	6.0	L	105	11.0	Me	079	10.3	Cy	104	9.9	Sh
067	7.8	Ch	151731			094	5.6	Me	107	10.9	Pt	093	8.0	Jo	106	10.3	El
078	7.3	Ah	039	8.8	Ch	095	6.0	Cy	Z Sco			095	8.4	Cy	123	11.3	El
088	7.6	Jo	065	9.7	Ch	095	6.0	Oy	*160021*			097	7.7	Jo	RR Oph		
093	7.3	Jo	097	10.4	Jo	096	6.0	Cy	079	11.9	L	107	7.4	Pt	*164319*		
096	7.4	Jo	097	10.1	El	096	5.8	Jo	103	12.2	L	SS Her			083	8.7	L
101	7.9	Ah	102	10.4	Ah	097	6.1	Cy	105	12.3	Me	162807			099	8.6	L
102	7.7	Ah	107	11.0	Pt	097	6.0	Jo	R Her			079	11.2	Cy	S Her		
107	7.6	Pt	121	11.4	El	099	6.0	L	160118			079	10.9	L	164715		
V Lib			125	11.8	El	099	6.0	Ra	095	13.3	Cy	095	12.6	Cy	094	8.0	Jo
143417			RS Lib			099	5.9	Me	U Ser			097	11.0	Jo	097	8.0	Jo
103[14.2		L	*151822*			101	6.0	Pt	160210			099	13.2	L	RV Her		
U Boo			082	9.7	L	101	6.0	Cy	095	9.1	Cy	105	12.0	Me	165631		
144918			099	8.6	L	101	6.1	Ah	102	9.1	Cy	123	11.4	El	079	11.1	L
079	11.9	Cy	106	8.4	Me	102	6.2	Ah	107	9.8	Pt	T Oph			094	11.0	Jo
095	10.9	Cy	RU Lib			102	6.3	Cy	X Sco			*162815*			097	11.3	Jo
121	10.8	El	*152714*			103	6.0	L	*160221a*			103	12.5	L	099	10.9	L
125	10.8	El	082	11.6	L	105	5.9	Me	079	12.0	L	S Oph			123	12.1	El
Y Lup			099	12.7	L	106	6.0	Me	103	11.1	L	*162816*			R Oph		
145254			106	12.7	Me	107	5.7	Pt	SX Her			103	11.7	L	*170215*		
068	10.0	Bl	107	13.2	Pt	109	5.9	Ra	160325			W Her			099	10.7	L
S Aps			X Lib			113	6.0	Ra	079	8.2	L	163137			RT Her		
145971			*153020*			X CrB			094	8.0	L	028[11.2		Ch	170627		
042	10.8	Bl	079	12.0	L	154536			099	8.0	Me	069	10.0	Ch	124[13.8		El
051	10.8	Bl	094	11.0	L	082	10.1	L	103	8.8	L	091	8.4	Jo	Z Oph		
059	10.8	Sl	103	10.8	L	095	9.6	Cy	105	8.0	Me	093	8.2	Jo	171401		
060	10.8	Bl	W Lib			099	10.2	L	106	7.9	Me	097	8.0	Jo	078	11.6	Cy
068	10.7	Bl	*153215*			106	10.9	Me	107	8.9	Pt	106	8.1	Me	095	12.0	Cy
RT Lib			103	14.0	L	107	11.2	Pt	RU Her			123	8.3	El	RS Her		
150018			S UMi			R Ser			160625			R UMi			171723		
107	9.6	Pt	153378			154615			079	11.9	Cy	163172			094	10.5	Jo
T Lib			069	11.8	Ch	066	7.2	Ch	079	11.9	L	074	9.4	Jo	097	10.3	Jo
150569			074	10.5	Jo	095	8.2	Cy	095	11.6	Cy	079	9.7	L	S Oct		
082	10.7	L	074	11.6	Ko	107	8.8	Pt	103	12.2	L	086	9.7	L	*172486*		
095	11.3	L	088	10.4	Jo	V CrB			105	12.3	Me	088	9.4	Jo	042	9.6	Bl
108	12.0	L	093	10.5	Jo	154639			107	13.0	Pt	091	9.3	Jo	051	9.9	Bl
107	12.7	Pt	093	11.1	Ko	088	8.2	Jo				093	10.2	Mc	059	9.8	Sl
			096	10.4	Jo	093	8.4	Jo				094	10.1	Mc	060	10.3	Bl

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J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

S OCT
172486
062 10.7 Ht
067 11.0 Bl
RU OPH
172809
083 10.7 L
097 11.0 Jo
099 10.6 L
RT SER
173411
103 13.1 L
RU SCO
173543
043 9.2 Bl
W PAV
174162
043 11.0 Bl
051 9.7 Bl
059 9.1 Sl
060 9.2 Bl
067 9.1 Bl
T DRA
175458a
041 10.8 Ch
124 9.5 El
UY DRA
175458b
041 10.8 Ch
124 10.5 El
RY HER
175519
028 9.2 Ch
083 10.8 L
099 11.8 L
V DRA
175654
041 14.0 Ch
086 13.2 L
099 12.5 L
T HER
180531
032 8.8 Ch
041 9.9 Ch
083 12.7 L
097 12.5 Jo
099 12.7 L
105 12.7 Me
124 10.9 El
W DRA
180565
041 14.1 Ch
086 14.1 L
099 13.1 L
X DRA
180666
041[14.1 Ch
TV HER
181031
103 14.0 L

W LYR
181136
074 12.4 Jo
097 9.8 Jo
083 11.6 L
099 10.1 L
RV SGR
182133
044 10.4 Bl
SV HER
182224
099 13.9 L
SV DRA
183149
082 10.1 L
099 10.0 L
RZ HER
183225
083 9.8 L
099 9.8 L
X OPH
183308
028 8.2 Ch
038 8.0 Ch
083 7.0 L
095 7.4 Cy
099 6.9 L
RS DRA
184074
032 9.8 Ch
058 9.4 Ch
RY LYR
184134
033 13.3 Ch
061 10.5 Ch
082 10.8 L
086 10.5 L
099 10.6 L
R SCT
184205
035 6.1 Ch
079 5.3 L
083 5.0 L
094 5.1 L
095 5.2 Cy
103 5.1 L
105 5.3 Me
107 5.1 Pt
115 5.3 Ra
NOV AQL
184300
028 10.7 Ch
107 11.6 Pt
RX LYR
185032
033[13.0 Ch
061[13.0 Ch
S CRA
185437a
044 11.8 Bl

ST SGR
185512a
035 8.0 Ch
103 11.6 L
R CRA
185537a
044 12.0 Bl
T CRA
185537b
044 13.0 Bl
Z LYR
185634
033 12.9 Ch
061 12.0 Ch
082 10.6 L
086 10.2 L
099 9.9 L
RT LYR
185737
033 12.9 Ch
061[13.0 Ch
127[13.9 El
V AQL
185905
032 7.2 Ch
R AQL
190108
032 8.5 Ch
058 10.0 Ch
V LYR
190529a
033 13.4 Ch
061[13.3 Ch
RX SGR
190818
035[12.4 Ch
RW SGR
190819a
035 9.4 Ch
S LYR
190925
033[13.8 Ch
061[13.5 Ch
103 13.8 L
RS LYR
190933a
033 10.6 Ch
062 11.9 Ch
083 13.0 L
103 13.4 L
RU LYR
190941
063 12.8 Ch
U DRA
190967
033 13.5 Ch
086 13.6 L
099 13.1 L

W AQL
191007
034 13.8 Ch
T SGR
191017
035 11.4 Ch
R SGR
191019
035 9.9 Ch
RY SGR
191033
028 6.8 Ch
044 6.6 Bl
051 6.5 Bl
062 6.5 Bl
TY SGR
191124
044 10.1 Bl
S SGR
191319a
035[12.7 Ch
SW SGR
191331
044 11.0 Bl
051 11.0 Bl
TZ CYG
191350
074 10.4 Jo
088 10.2 Jo
091 10.2 Jo
094 10.5 Jo
096 10.6 Jo
U LYR
191637
074 9.2 Jo
078 9.2 Jo
088 9.4 Jo
091 9.6 Jo
096 9.8 Jo
105 10.2 Me
AF CYG
192745
075 7.0 Ah
076 7.2 Ah
078 7.1 Ah
087 7.5 Ah
101 7.6 Ah
104 7.5 Ah
TY CYG
192928
033 13.2 Ch
062 11.8 Ch
082 11.8 L
093 11.7 L
RT AQL
193311
033 13.2 Ch
R CYG
193449
021 6.4 Ch

R CYG
193449
038 6.6 Ch
041 6.5 Ch
046 6.5 Ch
053 6.9 Ch
063 7.2 Ch
072 8.0 Ch
074 7.4 Jo
075 7.9 Ah
076 7.7 Ah
076 7.7 Oy
078 7.9 Ah
078 7.6 Jo
081 7.7 Jo
087 8.2 Ah
088 7.8 Jo
090 7.7 El
090 7.7 Pt
091 8.6 Mc
091 7.7 Jo
092 8.7 Mc
092 8.4 Wd
093 9.0 Mc
093 8.1 Ko
094 9.3 Mc
094 8.2 Jo
095 9.6 Mc
095 8.5 Oy
095 7.5 Si
096 8.3 Wd
096 8.2 Jo
098 9.0 Oy
104 8.6 Ah
124 9.3 El
127 9.5 El
RV AQL
193509
080 8.8 L
T PAV
193972
044 11.4 Bl
051 11.6 Bl
060 12.6 Bl
062 12.6 Ht
RT CYG
194048
033 11.7 Ch
058 9.4 Ch
068 8.5 Ch
074 8.2 Jo
075 8.4 Ah
076 8.1 Ah
076 7.9 Oy
078 8.1 Ah
078 8.1 Jo
079 7.9 Ko
081 7.5 Jo
086 7.7 Ko
087 8.0 Ah

RT CYG
194048
088 7.5 Jo
090 7.5 El
090 7.6 Pt
091 7.4 Jo
091 8.2 Mc
092 8.3 Mc
092 6.9 Wd
093 7.4 Ko
094 8.5 Mc
094 7.3 Jo
095 8.5 Mc
095 8.0 Oy
096 7.5 Jo
096 7.7 Wd
098 7.9 Oy
099 7.8 Ko
101 8.0 Ah
104 8.2 Ah
128 8.5 El
TU CYG
194348
033 12.0 Ch
041 12.3 Ch
077[11.7 Ry
086 14.1 L
097[12.2 Ry
X AQL
194604
034 12.6 Ch
X CYG
194632
031 5.2 Ch
036 5.3 Ch
041 5.4 Ch
058 6.0 Ch
062 6.2 Ch
068 6.6 Ch
071 6.7 Ch
072 6.8 Ch
074 6.5 Jo
075 6.7 Ah
076 6.8 Ah
076 7.1 Oy
078 6.5 Jo
081 6.8 Jo
086 6.8 Cy
087 7.3 Ah
088 7.7 Wd
088 7.6 Jo
090 7.2 Pt
091 7.6 Jo
092 7.6 Cy
093 7.5 Ko
094 7.7 Jo
097 8.0 Jo
105 9.0 Me
128 9.7 El

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
S PAV	S AQL	RS CYG	Z DEL	T DEL	X CEP
194659	200715a	200938	202817	204016	210382
059 7.5 Sl	088 11.5 Jo	103 8.0 GD	034 13.5 Ch	078 9.7 Jo	067[12.1 Ch
RR SGR	105 11.2 Me	106 7.3 Ad	063 13.5 Ch	080 10.0 L	Z CAP
194929	RW AQL	SX CYG	080 10.2 L	088 10.4 Jo	*210516*
044 9.6 Bl	200715b	201130	093 9.7 L	091 10.7 Jo	035 13.5 Ch
051 9.1 Bl	074 10.0 Jo	066[13.1 Ch	ST CYG	093 10.8 L	060[12.5 Ch
062 8.4 Bl	088 9.6 Jo	090[13.1 Pt	202954	094 10.8 Jo	R EQU
RU SGR	R TEL	RT SGR	033 13.5 Ch	V AQR	210812
195142	*200747*	*201139*	066 12.6 Ch	204102	074 8.9 Jo
044 8.6 Bl	044 10.2 Bl	044 10.6 Bl	080 12.1 L	082 9.0 L	078 8.9 Jo
051 9.0 Bl	051 10.7 Bl	051 9.9 Bl	090 11.9 Pt	U CAP	078 9.8 L
060 9.7 Bl	060 11.1 Bl	062 9.6 Bl	099 11.2 L	*204215*	090 11.1 Pt
068 9.9 Bl	068 11.3 Bl	068 9.3 Bl	V VUL	035 13.6 Ch	094 10.6 L
RR AQL	RU AQL	WX CYG	203226	060[13.1 Ch	T CEP
195202	200812	201437b	090 9.2 Pt	V DEL	210868
034 13.2 Ch	034 12.4 Ch	033 11.2 Ch	R MIC	204318	028 7.5 Ch
RS AQL	082 9.7 L	066 11.8 Ch	*203429*	066 13.1 Ch	045 7.1 Ch
195308	W CAP	074 12.0 Jo	062 10.9 Bl	T AQR	052 7.0 Ch
035 12.8 Ch	*200822*	078 11.9 Jo	068 10.6 Bl	*204405*	058 6.7 Ch
NOV CYG	044[12.5 Bl	080 12.0 L	Y DEL	035 8.0 Ch	063 6.6 Ch
195553	Z AQL	081 12.0 Jo	203611	046 8.9 Ch	069 6.7 Ch
033[13.2 Ch	*200906*	088 12.2 Jo	066[13.1 Ch	068 10.2 Ch	072 7.1 Ch
087[12.2 Pt	035 9.3 Ch	090 12.2 Pt	S DEL	RZ CYG	074 6.5 Jo
RR TEL	R SGE	091 12.5 Jo	203816	204846	075 6.5 Ah
195656	200916	093 12.1 L	034 8.8 Ch	074 11.4 Jo	076 6.7 Ah
065[12.6 Ht	035 9.0 Ch	094 12.7 Jo	066 9.0 Ch	090 11.7 Pt	076 6.9 Oy
Z CYG	058 9.6 Ch	096 12.5 Jo	074 9.0 Jo	S IND	077 7.1 Th
195849	074 8.7 Jo	V SGE	078 9.4 Jo	*204954*	078 6.5 Ah
042 13.2 Ch	088 9.0 Jo	201520	088 10.4 Jo	044 10.0 Bl	078 6.6 Jo
073 12.0 Ch	105 8.6 Me	105 11.9 Me	091 10.5 Jo	051 10.6 Bl	085 7.1 Ra
080 10.8 L	RS CYG	U CYG	094 11.0 Jo	060 11.0 Bl	086 5.9 Ko
088 11.2 Jo	200938	201647	V CYG	065 11.4 Ht	087 6.4 Ah
090 10.5 Pt	028 9.0 Ch	033 10.5 Ch	203847	068 11.1 Bl	087 6.9 Ra
093 9.8 L	033 8.9 Ch	058 10.0 Ch	033 11.8 Ch	X DEL	088 6.3 Jo
094 10.5 Jo	041 8.6 Ch	074 8.7 Jo	058 10.6 Ch	205017	090 5.8 Th
096 9.9 Jo	053 8.7 Ch	074 8.9 Ko	072 9.9 Ch	093 13.0 L	090 6.6 Ra
104 9.1 L	058 8.3 Ch	078 8.6 Jo	074 9.8 Jo	T OCT	090 6.0 Pt
S TEL	066 7.6 Ch	081 8.3 Jo	074 10.2 Ko	*205782*	092 6.2 Jo
195855	069 8.3 Ch	088 8.6 Jo	078 9.6 Jo	059 8.9 Sl	092 6.5 Hf
065[12.6 Ht	072 8.2 Ch	088 8.4 Ko	080 9.5 L	R VUL	093 6.4 Hf
SY AQL	074 7.4 Jo	090 9.5 Pt	081 9.5 Jo	205923a	093 6.4 Sh
200212	078 7.4 Jo	091 8.5 Jo	088 9.4 Jo	038 9.1 Ch	094 6.1 Jo
034 9.6 Ch	080 7.8 L	091 9.2 Mc	088 10.3 Ko	063 12.0 Ch	094 6.5 Ad
080 10.6 L	081 7.3 Jo	092 9.2 Mc	090 10.1 Pt	074 12.4 Jo	094 5.3 Th
S CYG	086 8.3 Cy	092 9.5 Wd	091 9.3 Jo	081 12.4 Jo	094 6.5 Ra
200357	088 7.4 Jo	093 9.2 Mc	093 9.6 L	090 12.5 Pt	095 6.3 Oy
033 11.6 Ch	088 7.8 Ko	094 9.2 Mc	094 9.4 Jo	091 12.6 Jo	095 6.4 Si
063 12.6 Ch	090 7.5 Pt	094 8.6 Jo	096 9.4 Jo	094 12.5 Jo	096 6.0 Jo
073 13.1 Ch	091 7.3 Jo	095 8.6 Si	099 10.2 Ko	096 12.5 Jo	096 6.5 Wd
090[12.4 Pt	092 8.2 Wd	096 9.6 Wd	104 9.9 L	V CAP	097 5.1 Th
128[13.8 El	092 7.9 Hf	096 8.3 Jo	Y AQR	*210124*	097 6.5 Ra
R CAP	093 7.5 L	099 8.2 Ko	*203905*	062[12.5 Bl	098 6.5 Ra
200514	094 7.4 Ad	103 8.0 GD	035 10.5 Ch	TW CYG	098 5.0 Th
035 12.1 Ch	094 7.2 Jo	104 9.5 Ah	068 9.0 Ch	210129	099 4.9 Th
S AQL	095 8.3 Cy	U MIC	T DEL	093 14.1 L	101 6.2 Ah
200715a	096 7.2 Jo	*202240*	204016	X CAP	102 6.1 Ah
035 9.8 Ch	098 7.7 Oy	062[13.0 Bl	034 9.0 Ch	*210221*	103 6.2 Oy
063 11.4 Ch	099 7.7 Ko		066 9.6 Ch	062[12.7 Bl	104 6.2 Ah
074 11.7 Jo	103 7.4 L		074 9.4 Jo		105 6.5 Ra

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1933.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
T CEP	S CEP	RT PEG	R IND	W PEG	R AQR
210868	213678	215934	*222867*	231425	*233815*
105 6.1 Ad	096 8.8 Jo	034 12.0 Ch	068 8.8 Bl	096 9.5 Jo	057 8.7 Sl
106 6.4 Ra	RU CYG	060 10.0 Ch	T TUC	103 9.7 L	059 8.7 Ch
107 6.2 Ra	213753	RY PEG	*223462*	S PEG	060 8.9 Bl
110 6.2 Ra	074 9.6 Jo	220133a	062 13.5 Ht	231508	062 8.1 Ht
115 5.7 Ad	074 10.1 Ry	103 12.5 Bw	R LAC	035 9.0 Ch	068 8.3 Bl
128 5.7 El	077 10.1 Ry	109 12.5 Bw	223841	060 7.8 Ch	072 8.4 Ch
RR AQR	078 9.6 Jo	RZ PEG	035 13.8 Ch	076 8.5 Ah	074 8.5 Jo
210903	078 10.0 Ah	220133b	060 12.3 Ch	078 8.6 Ah	075 8.4 Bf
034 13.9 Ch	086 10.0 Cy	090 12.0 Pt	072 11.3 Ch	082 8.1 L	078 8.6 Jo
Y PAV	087 10.0 Ah	092 12.4 Jo	082 10.3 L	084 8.6 L	079 8.4 Ko
211570	088 9.7 Jo	094 13.5 L	088 9.8 Jo	087 9.1 Ah	079 8.6 L
062 5.6 Ht	088 9.8 Je	T PEG	090 9.7 Pt	090 8.6 Pt	090 8.5 Pt
X PEG	090 8.9 Pt	220412	091 9.7 Jo	092 9.0 Cy	093 8.6 L
211614	091 9.7 Jo	082 12.0 L	094 9.2 Jo	098 9.1 B	095 8.5 Si
094 12.5 L	092 9.6 Mc	094 11.7 L	094 9.1 L	103 8.9 L	096 8.4 Ko
104 11.4 L	092 10.0 Je	103 11.6 L	096 9.1 Jo	RY CEP	099 8.6 Ko
T CAP	093 9.9 Cy	Y PEG	103 8.7 L	231878	099 8.6 L
211615	094 9.6 Jo	220613	RW PEG	032 9.6 Ch	Z CAS
035[13.3 Ch	094 10.0 Mc	090 11.9 Pt	225914	058 9.4 Ch	233956
068[11.8 Bl	094 10.2 Ry	094 11.5 Jo	079 12.9 L	V PHE	036 11.3 Ch
S MIC	096 9.9 Jo	RS PEG	093 11.9 L	*232746*	060 12.0 Ch
212030	097 10.3 Ry	220714	096 11.5 Wa	062[13.2 Ht	083 12.9 L
062 12.1 Bl	099 10.1 Ry	082 11.9 L	099 11.5 Wa	Z AND	094 13.2 L
068 10.8 Bl	102 10.1 Ry	090 11.8 Pt	099 11.6 L	232848	096 12.9 Mg
Y CAP	104 9.9 Ah	094 12.2 L	106 10.7 Wa	036 10.4 Ch	097 13.3 Bw
212814	RV CYG	104 12.2 L	109 10.2 Wa	060 10.4 Ch	098 13.0 B
035 10.8 Ch	213937	S GRU	R PEG	074 10.5 Ko	107 13.3 Bw
044 11.0 Bl	090 6.5 Pt	*221948*	230110	075 10.3 Cy	RR CAS
051 11.0 Bl	RR PEG	062 11.6 Ht	034 9.8 Ch	078 10.3 Cy	235053
060 11.4 Ch	214024	RV PEG	058 10.4 Ch	090 10.6 Pt	094 11.3 Bn
062 11.2 Bl	060 10.2 Ch	222129	069 10.9 Ch	094 10.5 Jo	098 11.4 Bn
068 11.2 Bl	074 10.3 Jo	034[13.3 Ch	090 11.4 Pt	096 10.4 Bw	098 11.4 B
W CYG	088 10.4 Jo	060[13.3 Ch	V CAS	104 10.6 Ko	V CET
213244	090 10.1 B	094 13.7 L	230759	ST AND	*235209*
080 6.7 L	091 10.5 Jo	104 13.5 L	040 11.8 Ch	233335	040 11.8 Ch
091 6.5 Mc	092 10.1 Cy	S LAC	060 11.9 Ch	036 10.2 Ch	044 11.3 Bl
092 6.5 Mc	094 10.5 Cy	222439	072 12.0 Ch	059 9.5 Ch	051 10.6 Bl
093 6.5 Mc	096 10.4 Jo	074 8.2 Ko	075 12.0 Cy	074 8.8 Jo	060 9.4 Bl
094 6.5 Mc	R GRU	082 8.7 L	088 11.7 El	078 8.8 Jo	060 9.3 Ch
094 6.7 L	*214247*	088 8.9 El	090 11.4 Pt	087 9.0 Cy	068 9.4 Bl
095 6.4 Mc	044 9.0 Bl	088 9.0 Jo	092 11.1 Cy	088 8.8 Jo	R TUC
096 6.4 Mc	051 9.0 Bl	090 9.0 Pt	099 10.7 B	090 9.5 Pt	*235265*
104 6.6 L	055 9.5 Ht	090 8.9 B	101 10.8 Ko	091 8.8 Jo	059[13.5 Sl
S CEP	060 9.3 Bl	091 9.1 Jo	102 10.7 Ah	093 9.0 Jo	062[13.5 Ht
213678	062 9.8 Ht	093 9.1 BL	128 9.5 El	093 9.0 BL	R CAS
032 10.2 Ch	068 9.8 Bl	094 9.5 Jo	W PEG	094 9.0 B	235350
067 10.2 Ch	V PEG	094 9.1 L	231425	096 8.8 Mg	040 12.0 Ch
074 8.8 Jo	215605	096 9.5 Mg	035 12.0 Ch	096 9.1 BL	060 12.5 Ch
076 10.5 Je	034 11.5 Ch	096 9.0 BL	060 11.7 Ch	096 8.9 Jo	072 12.8 Ch
077 9.7 Je	060 12.5 Ch	096 9.4 Jo	074 9.9 Jo	107 8.8 BL	098 12.7 B
078 8.8 Jo	094[13.5 L	099 9.2 Ko	078 9.9 Jo	R AQR	Z PEG
087 9.6 Je	U AQR	103 9.5 L	082 10.6 L	*233815*	235525
088 8.7 Jo	*215717*	107 10.1 BL	088 10.0 Jo	031 8.4 Ch	040 10.5 Ch
090 9.0 Pt	035 11.6 Ch	R IND	091 9.6 Jo	044 8.5 Bl	060 9.4 Ch
092 9.6 Je	060 12.1 Ch	*222867*	092 9.5 Cy	046 8.4 Ch	082 8.5 L
092 9.8 Cy		044 11.8 Bl	094 9.6 Jo	051 8.6 Bl	090 8.6 Pt
092 8.7 Jo		051 11.4 Bl	094 10.1 L	055 8.2 Ht	094 8.2 L
094 8.8 Jo		060 9.5 Bl	096 10.2 Bw	057 8.6 Ch	094 8.4 Jo

Variable Star Observations Received During February, 1933.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
Z Peg			W Cet			SV And			SV And			SV And			SV And		
235525			*235715*			235939			235939			235939			235939		
096	8.3	Jo	072	13.9	Ch	040	8.3	Ch	078	8.8	Jo	093	10.0	Jo	096	10.4	Bw
103	8.8	L	Y Cas			060	8.0	Ch	087	9.3	Cy	096	10.3	Jo	096	10.4	Mg
W Cet			235855			062	8.3	Cy	088	9.0	Jo	091	9.6	Jo	098	10.0	B
235715			089	14.1	B	074	8.4	Jo	090	9.4	Pt						
040	12.8	Ch	094	14.0	L												

Rapidly Varying Irregular Variables.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
005840 RX Andromedae—						
	7043.2	11.5	Ch	7096.4	11.7	Ry
	7066.2	11.5	Ch	7096.7	12.2	Pt
	7074.5	11.7	Ry	7097.4	11.8	Ry
	7074.6	11.2	Ko	7099.4	11.7	Ry
	7077.4	11.6	Ry	7100.4	11.6	Ry
	7082.3	11.5	Ry	7101.4	11.8	Ry
	7086.6	11.5	Pt	7101.6	11.4	Me
	7087.3	11.5	Ry	7102.3	11.8	Ry
	7087.7	11.5	Pt	7104.6	11.3	Me
	7090.7	11.5	Pt	7115.6	11.6	Me
	7094.3	11.6	Ry	7116.6	11.8	Me
060547 SS Aurigae—						
	7033.2	12.6	Ch	7096.6	12.2	Wa
	7036.2	13.9	Ch	7096.7	11.8	Pt
	7061.1	10.8	Ch	7096.7	12.0	El
	7065.1	13.0	Ch	7097.4	12.2	Ry
	7072.1	[13.8	Ch	7097.5	12.3	Wa
	7074.4	14.3	L	7097.5	12.1	B
	7077.7	[12.5	Ry	7097.6	12.0	Pt
	7079.7	14.3	L	7097.7	12.4	Cy
	7082.3	[12.5	L	7098.5	12.9	B
	7083.3	[12.5	L	7098.5	12.8	Ry
	7084.2	[12.5	L	7099.3	13.5	L
	7085.3	[12.5	L	7099.4	13.4	Ry
	7086.6	[12.6	Pt	7099.5	13.6	B
	7087.3	[13.2	Ry	7101.5	13.8	B
	7088.6	[13.2	El	7103.3	14.1	L
	7092.5	13.8	B	7104.3	[13.9	L
	7093.3	11.0	L	7105.7	[12.5	Pt
	7093.6	11.0	Cy	7106.0	[12.5	Me
	7094.3	10.8	L	7107.9	[12.5	Pt
	7094.5	10.9	B	7109.5	[12.6	Wa
	7094.6	11.1	Ry	7115.6	[13.0	Me
	7095.4	11.6	Ry	7116.6	[13.0	Me
	7095.6	11.4	Cy	7119.7	12.6	El
	7096.4	12.1	Ry	7121.6	11.4	El
	7096.5	11.5	Cy	7125.7	[13.0	El
	7096.6	11.9	BL	7127.7	[14.0	El
074922 U Geminorum—						
	7036.2	14.2	Ch	7079.7	9.7	L
	7063.2	14.1	Ch	7079.9	9.5	Cy
	7066.2	13.5	Ch	7080.7	9.6	Cy
	7071.1	9.6	Ch	7082.3	11.0	L
	7073.2	9.3	Ch	7082.7	11.6	L
	7074.4	9.2	L	7090.6	13.7	B
	7079.4	9.7	L	7092.5	13.9	B
074922 U Geminorum—						
	7092.8	14.0	El	7104.3	13.8	L
	7094.5	14.1	B	7106.8	14.0	El
	7095.8	14.3	Ma	7119.7	13.7	El
	7096.7	14.0	El	7121.7	13.6	El
	7099.4	14.2	L	7122.8	14.0	Ma
	7099.6	14.0	B	7125.7	13.8	El
	7101.5	14.0	B	7127.7	14.1	El
	7103.3	13.8	L			
081473 Z Camelopardalis—						
	7046.4	11.5	Ch	7096.4	12.0	Ry
	7067.2	12.0	Ch	7096.7	11.8	Pt
	7072.8	12.0	Cy	7096.7	11.2	Cy
	7074.4	12.1	L	7096.7	12.1	El
	7074.5	12.2	Ry	7097.4	12.3	Ry
	7074.5	11.9	Ko	7097.6	12.0	Pt
	7077.7	12.2	Ry	7098.5	12.3	Ry
	7078.9	12.0	Cy	7099.4	12.7	Ry
	7079.4	12.1	L	7099.4	12.9	L
	7082.3	12.7	L	7099.9	12.8	Me
	7082.7	12.5	L	7100.4	12.8	Ry
	7083.3	12.7	L	7101.4	12.9	Ry
	7083.7	12.8	L	7101.6	13.1	Me
	7084.2	12.5	L	7101.8	12.3	Pt
	7085.3	12.6	L	7102.7	12.6	Cy
	7086.6	12.8	Pt	7103.3	13.1	L
	7087.7	12.7	Pt	7103.6	13.0	L
	7090.7	10.7	Pt	7104.3	13.0	L
	7092.7	11.0	L	7105.7	12.5	Pt
	7092.8	11.2	Cy	7106.0	13.1	Me
	7092.8	11.3	El	7106.8	12.8	El
	7093.6	11.4	Ko	7107.0	13.1	Me
	7094.3	11.6	L	7107.9	12.7	Pt
	7094.5	11.7	Ry	7115.6	13.0	Me
	7094.7	11.3	L	7116.6	12.3	Me
	7095.4	11.6	Ry	7121.7	11.2	El
	7095.7	11.6	L	7125.7	11.4	El
094512 X Leonis—						
	7096.8	13.5	El	7107.0	[12.7	Me
	7101.8	[12.6	Pt	7116.6	12.1	Me
	7106.8	[13.5	El	7127.8	[13.5	El
212946 SZ Cygni—						
	7086.6	9.6	Pt	7097.6	9.0	Pt
	7087.7	9.8	Pt	7105.7	9.1	Pt
	7090.7	9.5	Pt	7107.9	8.8	Pt
	7096.7	8.9	Pt			

VARIABLE STAR OBSERVATIONS RECEIVED DURING FEBRUARY, 1933.

Star	J.D.	Est.Obs.	J.D.	Est.Obs.	Star	J.D.	Est.Obs.	J.D.	Est.Obs.
213843 SS CYGNI—					213843 SS CYGNI—				
	7031.1	11.8 Ch	7082.2	12.0 L		7094.6	9.0 Jo	7101.2	8.6 Ah
	7034.1	11.9 Ch	7083.2	12.1 L		7094.6	8.5 Mc	7101.5	8.5 Ko
	7040.2	11.8 Ch	7083.7	12.1 L		7095.5	8.8 Hu	7101.5	8.7 Wa
	7052.1	8.8 Ch	7084.2	12.0 L		7095.5	8.6 Si	7101.6	8.8 Me
	7055.1	8.7 Ch	7085.3	12.0 L		7095.6	8.6 Mc	7101.5	8.5 Ae
	7058.1	9.6 Ch	7086.3	12.2 L		7096.5	8.6 Wa	7103.2	8.7 L
	7061.1	11.2 Ch	7086.6	11.7 Pt		7096.6	8.7 Wd	7103.6	8.6 Mg
	7061.6	11.8 He	7087.3	12.0 Ah		7096.6	8.8 Jo	7103.7	8.7 L
	7064.2	11.9 Ah	7087.7	11.8 Pt		7096.6	8.9 Mc	7104.2	8.7 L
	7069.6	11.9 Mg	7088.5	11.9 El		7096.6	8.9 Mg	7104.3	8.7 Ah
	7071.1	11.9 Ch	7088.6	12.0 Jo		7096.6	9.0 Si	7104.5	8.6 Ae
	7074.4	12.1 L	7089.5	11.8 Hu		7096.7	8.8 Pt	7104.6	9.0 Me
	7074.5	11.7 Ko	7090.7	11.7 Pt		7097.5	8.7 Hu	7105.7	9.0 Pt
	7074.6	11.9 Jo	7091.6	11.7 Jo		7097.5	8.7 Wa	7106.0	9.2 Ae
	7075.4	12.0 Ah	7092.5	11.6 B		7097.6	8.9 Pt	7106.0	9.0 Me
	7075.6	12.0 Bc	7092.5	11.9 Wd		7097.6	8.8 Jo	7106.5	9.3 Wa
	7076.6	12.0 Bc	7092.5	11.8 Wa		7097.9	8.6 Jo	7107.0	9.0 Me
	7076.6	12.0 Bf	7092.7	11.0 L		7098.6	8.5 Mg	7107.5	9.5 Wa
	7078.3	11.8 Ah	7093.2	10.8 L		7099.2	8.6 L	7107.9	9.5 Pt
	7078.6	12.0 Jo	7093.5	9.8 Ko		7099.5	8.6 Ko	7109.5	10.2 Wa
	7079.3	12.1 L	7093.5	9.5 Hu		7099.5	8.2 Wa	7115.6	11.8 Me
	7080.3	12.1 L	7093.5	9.6 Wa		7099.7	8.4 L	7116.6	11.8 Me
	7080.5	11.9 Cy	7093.6	9.2 Mc		7100.5	8.5 Hu	7128.0	12.1 El
	7081.6	11.9 Jo	7094.2	8.8 L					

SUMMARY FOR FEBRUARY, 1933.

Observer	Initial	Vars.	Observations	Observer	Initial	Vars.	Observations
Ahnert	Ah	36	122	Kohman	Ko	29	71
Aldwell	Ad	9	27	Lacchini	L	155	401
Allen, L. B.	Ae	1	3	Marsh	Ma	25	34
Baldwin, J. M.	Bl	73	205	McLeod	Mc	14	45
Bigelow	Bw	17	24	Meek	Me	63	103
Boutell	BL	14	40	Monnig	Mg	21	24
Bouton	B	57	71	O'Byrne	Oy	14	25
Brown, A. N.	Bn	4	13	Peltier	Pt	154	205
Buckstaff, E.M.	Bf	4	5	Raphael	Ra	8	51
Buckstaff, R.N.	Bc	3	5	de Roy	Ry	9	49
Chandra	Ch	214	458	Schenkman	Se	2	7
Cilley	Cy	61	100	Shinkfield	Sl	21	27
Eliason	El	75	153	Shultz	Sz	2	2
Godfrey Club	GD	3	3	Simpson	Si	8	10
Hartmann	Hf	16	27	Smith, F. P.	Sq	2	4
Hess	He	3	3	Smith, F. W.	Sf	5	11
Houghton	Ht	45	51	Smith, L.	Sh	15	19
Hunter	Hn	10	10	Theile	Th	3	10
Hurahata	Ht	1	5	Watson	Wa	7	20
Jansen	Je	7	23	Webb	Wd	23	52
Jones	Jo	111	441				
Kaho	Ka	1	5	Totals		42	414	2964

March 11, 1933.

LEON CAMPBELL, Recorder.

General Notes

Professor Knut Lundmark, of Lund, Sweden, and Dr. Sture Holm, docent in the University of Lund, have been spending one and two months, respectively, at the Steward Observatory, of the University of Arizona, Tucson. Professor Lundmark studied some of the collection of nebular photographs, and Dr. Holm gathered stellar and nebular photometric data with the 3-foot reflecting telescope.

The Rittenhouse Astronomical Society of Philadelphia held its monthly meeting in the hall of The Franklin Institute, 15 South Seventh Street, Tuesday evening, March 14. The program consisted of an address, "The Dollonds and the Achromatic Lens" (Illustrated), by Mr. Harry B. Rumrill, and Astronomical Motion Pictures by the McMath Hulbert Observatory, Michigan.

The Warner Memorial Lecture for the year of 1933 was delivered by Professor J. J. Nassau, Case School of Applied Science, who took for his title "Eclipses and the Eclipse of 1932." These lectures are made possible through the generosity of Mrs. W. R. Warner in memory of her husband, one of the founders of The Warner and Swasey Company, and are under the auspices of the Cleveland Engineering Society.

Asteroids recently discovered by Dr. K. Reinmuth have been named as follows: the one discovered in February, 1927, *Astronomia;* that on January 26, 1928, *Aënna;* and that on March 19, 1930, *Kobolda.*

A New Star Discovered.—Under the date March 22 the following telegram was circulated from Harvard College Observatory:

> Copenhagen cables that Delporte and Stroobant report an eleventh magnitude nova observed March 20.8431 in right ascension $7^h\,18^m\,29^s.1$, in declination $+28°\,38'\,2''$.
>
> HARLOW SHAPLEY.

The Dark Spots of Hyginus and of Maupertius.—I observed the dark spots of Hyginus and Maupertius in 1929-30 with a telescope of 70 mm aperture, magnitude 117, using a diaphragm of 50 mm. In the neighborhood of Hyginus there are located six dark spots. All are probably invisible at sunrise and are easily visible when the longitude of the morning terminator is —32°. These spots are darker during the full moon but their size is invariable. Four days after full moon the spots are rather faint and at sunset they are invisible.

V. TSHERNOV.

The Reinmuth Asteroid 1932 HA

The possibility of a close approach of the Reinmuth asteroid 1932 HA. to the planet Venus has been mentioned by W. J. Luyten in the December (1932) number (p. 654). With the newest elements for the asteroid given by G. Stracke in *Astronomische Nachrichten,* Vol. 247, p. 289 (1932), F. E. Seagrave has repeated the computation. He finds that the minimum separation would take place when the asteroid's true anomaly is 45° 53′ and would be 0.00304 astronomical units, 282,000 miles, about three times as much as was indicated by the previous elements. This is the nearest distance of the two orbits but it will be a very long time before the two objects approach each other as near as that.

Cosmic Ray Experiment.—A novel and very unusual experiment for detecting cosmic rays is reported in *Amateur Astronomer* for March. We quote, "The rays, in order to reach the counter, had to penetrate the 360-ton steel vault with 30-inch steel walls, to say nothing of passing through the 34 stories of concrete and steel superstructure. The counters detected only those rays which came down vertically or at a very small angle.

"The space from which the cosmic rays were gathered was about six inches square, and the sound they made as they 'came in' was like that of pecking with a penknife on a wooden table top. The waves came in at the rate of 45 to 60 a minute, and frequently two would come close together and then there would be a gap.

"The director of this experiment, Dr. W. F. G. Swann, former President of the American Physical Society, is now Director of the Bartol Research Foundation. Others present in the vault included Dr. O. H. Caldwell, President of the New York Electrical Society, and member of the Executive Council, A.A.A.; Dr. Harlan T. Stetson, Director of Perkins Observatory, Ohio Wesleyan University, and Dr. Clyde Fisher, Curator of Astronomy at the American Museum of Natural History."

A Globe of Mercury.—Except for Mars and the moon Mercury is the only planet of the solar system which shows fixed markings on its surface. Taking into account libration and variable Mercurian latitude as seen from the earth we have made a globe of Mercury on which we have combined all the dependable observations made of this planet since the invention of the telescope. It is probably the first representation on a sphere of all the details which have been seen on Mercury in spite of the difficulties of telescopic observations. We have used the planispheres of Mercury made by Schiaparelli and Bidault.

This globe is in colors, the general tone being copper rose. The dark spots are represented in gray and the bright spots whitish in accordance with most of the observations of Mercury. The nomenclature used is that used by Bidault in his planisphere. It seems to us that this globe of Mercury supplements the globes of Mars and the moon already in existence.

We have likewise made the first synthetic chart of Mercury in normal projection which shows us a planisphere of Mercury on the side toward the sun at perihelion and aphelion.

LEONID AND ANNE ANDRENKO.

The Zodiacal Light on February 25, 1933

Out of the ten displays of the evening Zodiacal Light that were observed during the month of February, the display visible on February 25 was without a doubt, the most spectacular ever observed by any of us.

I first observed this display at 7:30 (C.S.T.) when the light was a dull orange, having a density greater than that of the star clouds in Scutum and Sagittarius. It was so beautiful that I called several neighbors out to watch it with us. At 7:30 P.M. the base extended from 13 Ceti to about 2 degrees southwest of ω Piscium. It covered δ and ϵ Piscium and γ Pegasi, extending nearly to η Piscium.

A continual change took place similar to the change in the palpitating streamers in the auroral display last May (1932). Indeed this display would easily have passed for an auroral display.

At 7:45 P.M. the light was placed as follows: The apex had swung from northwest of the Pleiades and north of the ecliptic to south of the ecliptic; and

whereas it before had covered Aries, it now was clear of it. The apex was slightly southeast of the Pleiades or at R.A. $3^h\ 42^m$, Decl. north 22 degrees. The apex was well defined in all cases.

The intensity changed and turned to a light golden yellow and spread so as to cover and include *g*, 55, γ Pegasi, 20 Ceti, ι and θ Piscium. At o and ϵ Piscium the light sent out a bright streamer to the northwest covering η, χ, ϕ, ν, τ Piscium, η and ξ Andromedae. The ray was 12 to 15 degrees wide and was also a golden color.

The sky was very clear and since we have at the "open air observatory," a nearly level horizon we were able to obtain a remarkable view of the phenomenon. At about 7:33 the apex reached the highest point of any apex that I have ever witnessed, approximately 73 degrees. All the points were sharply defined, though, as you can see by replotting the light on a star chart, the south side was the most brilliant.

Individuals who observed this phenomenon with me were Master A. M. Simpson, Mr. J. H. Miller, Miss Mary Miller, and Miss Helen Miller, all residents of this city.

J. Wesley Simpson.

639 Locksley Place, Webster Groves, Missouri, March 8, 1933.

A Remarkable Occultation of B.D. +10°303 by 27 Euterpe

1932 September 26, G.M.T., 23^h, I sought the minor planet *27* Euterpe with the 8-inch refractor of the Urania Observatory of Vienna. I had only a chart of the Bonner Durchmusterung. My search was fruitless. The star B.D. +10°303 was very bright and single, as it is marked on the chart. Nearly one hour later I sought again. Now the star B.D. +10°303 appeared as a double star. I thought that I now had found *27* Euterpe. Only the eastern star could be the minor planet. Again one hour later I looked at the star B.D. +10°303 and in its place were three stars. Now I was sure that I had found *27* Euterpe. It was the same distance from the eastern star as the components of the double star were apart. The positions of *27* Euterpe at the three observations were as follows:

At the first observation it was between the components; at the second observation it covered the eastern component; and at the third observation the occultation had already been finished some time before. Because on the map the star B.D. +10°303 was marked as single, I could not detect that *27* Euterpe was there. Such an observation with a strict statement of the occultation time is very important for the determination of the planet's orbit.

During the months of December and January the minor planet 8 Flora is in the Milky Way and occultations of stars by the planet are expected. The planet 8 Flora is of magnitude 8.2. Such an occultation occurs in a manner different from an occultation by the moon. Because the motion of the planet is slow, the star will at first appear as a double star, not quite separated. The exact moment of occultation therefore will be very difficult to observe.

Vienna. Frederick Schembor.

Astronomy in an Umbrella

The ancient umbrella is no longer to be despised. No matter how prehistoric its aspect, an honorable career may yet be its portion. Any owner so secretly ashamed of its general air of rusty shabbiness that he hesitates to raise his trusty gamp even when clouds lower and sudden raindrops patter may find for it another use.

For showers have nothing to do with this lively interest in the antiquated rain protector. Quite the contrary. The reason is to be read in the stars. And is a long and costly course in astronomy necessary for their perusal? It is not.

An article by Mr. Gaylord Johnson in the *Popular Science Monthly* brings the higher astronomy within the reach of everybody. No expensive telescope or magnifying lens is required. All that is needed is an old umbrella and a bit of white chalk. With such simple equipment and a few walks abroad on starlit nights the budding astronomer may decorate the sentimental moonlight dialogue with such casual and erudite remarks as: "That constellation, my dear, you will be happy to learn, is Cassiopeia," or "If you will disengage my arm a moment while I raise this umbrella, I shall show you the relative position of the Big Dipper to the Pole Star and you can then trace them in the sky."

It sounds very fascinating. Just a few chalk marks inside of any old umbrella to place the sixteen most important stars. A little practice as it is rotated counter-clockwise to correspond with the rotation of the earth and soon the umbrella is a picture of the sky. Star-gazing may even rival the jig-saw puzzle. And there is always the possibility of discovering a planet the great observatories have missed. It has been done. An English clergyman routed a new star out of its age-long hiding place with a pocket spyglass and got a medal from the Royal Astronomical Society.

With embryo astronomy breaking out everywhere, the family umbrella may spring another Copernicus upon a wondering world. (*The Christian Science Monitor*, March 6, 1933.)

THE OLD ASTRONOMER

Reach me down my Tycho Brahe, I would know him when we meet,
When I share my later science, sitting humbly at his feet.
He may know the law of all things, yet be ignorant of how
We are working to completion, working on from then till now.

Pray remember that I leave you all my theory complete,
Lacking only certain data for your adding, as is meet.
And remember men will scorn it; 'tis original and true,
And the obloquy of newness may fall bitterly on you.

But, my pupil, as my pupil you have learned the worth of scorn,
You have laughed with me at pity, we have joyed to be forlorn.
What for us are all distractions of men's fellowship and wiles!
What for us the Goddess Pleasure, with her meretricious smiles!

You may tell that German college that their honor comes too late,
But they must not waste repentance on the grizzly savant's fate.
Though my soul may set in darkness, it will rise in perfect light.
I have loved the stars too fondly to be fearful of the night.

What, my boy! You are not weeping! You should save your eyes for sight.
You will need them, mine observer, yet for many another night.
I leave none but you, my pupil, unto whom my plans are known.
You have none but me, you murmur, and I leave you "quite alone?"

Well then, kiss me. Since my mother left her blessing on my brow
There has been a something wanting in my nature until now.
I can dimly comprehend it that I might have been more kind.
Might have cherished you more wisely as the one I leave behind.

I "have never failed in kindness?" No, we lived too high for strife;
Calmest coldness was the error which has crept into my life.
But your spirit is untainted, I can dedicate you still
To the service of our science; you will further it—you will.

There are certain calculations I should like to make with you,
To be sure that your deductions will be logical and true.
But remember, "Patience, patience," is the watchword of a sage—
Not today, nor yet tomorrow can complete a perfect age.

I have sown, like Tycho Brahe, that a greater man may reap,
But if none should do my reaping 'twill disturb me in my sleep.
So be careful and be faithful, though like me you leave no name;
See, my boy, that nothing turn you to the mere pursuit of fame.

I must say good-bye, my pupil, for I can no longer speak.
Draw the curtains back for Venus, ere my vision grows too weak.
It is strange the pearly planet should look red like fiery Mars, —
God will mercifully guide me, on my way among the stars.

—ANONYMUS.

Communicated by Albert J. Brooks, 1150 Sterling Place, Brooklyn, N. Y.

Book Reviews

Non-Euclidean Geometry, or Three Moons in Mathesis, by Lillian R. Lieber, with drawings by Hugh Gray Lieber. (Academy Press, New York City.)

The above is the name given to a pamphlet of thirty-four pages, which, although copyrighted in 1931, has recently come to our desk. This pamphlet is unique in form and interesting in content. The basic ideas underlying the several geometries are tersely stated and jauntily illustrated. The text in appearance is in blank verse, but it is actually prose presented in this form for the convenience of the reader. This and the originality of the drawings beguile the reader from the subtleties of the subject. A closer look shows that a comprehension of the pamphlet requires a mind of some maturity. Anyone who has a measure, even though it be a small one, of geometric sensitiveness is assured a pleasant half hour or more with this work.

Eclipses of the Sun, 2nd Edition, by S. A. Mitchell. (Columbia University Press. Price $5.00.)

The new edition of Professor Mitchell's Eclipses of the Sun is very much like the two earlier editions in plan but it has been brought up to date in that the eclipses of 1925, 1926, 1927, 1929, and 1930 are included in description and discussion. The first half of the book is mainly historical. Beginning with the earliest of historical eclipses, that one in China in the 22nd century B. C., the reader can follow the development of the knowledge concerning eclipses down to the present time. For data and experiences from 1900 onward Professor Mitchell gives many of his experiences in eclipse work. The last half of the book deals with the theory and interpretation of eclipse observations. There are chapters on The Structure of the Atom, Photographing the Flash Spectrum, Discussing the Flash Spectrum, The Importance of Ionization, Heights and Related Problems, Heights and Dis-

tribution of Vapors, The Corona, Coronal Theories, The Einstein Theory of Relativity, Has the Einstein Theory been verified?, and Shadow Bands. This second half of the book, while not quite so easy to read as the first half, is of the greatest value to anyone who desires a modern discussion not only of eclipses but of the nature of the sun in general. In the opinion of the reviewer the book is the best one available in its field for the general reader.

Th following slips were noted: On page 59 the word moon has been used instead of sun four times. On page 132 the quotation above the middle of the page is too brief. Had it been continued it would have read ". . . told me I might lock myself in; but there was no occasion for this precaution . . ." E.A.F.

So This is Science, by H. F. Ellis, illustrated by Arthur Watts. (Methuen and Co., Ltd., 36 Essex St., London. Five shillings.)

Because of its glibness and its atmosphere of modernity this title leads one to expect something interesting. The assurance that "Here is a wild burlesque on the methods and phraseology of popular works of science" suggests something amusing. The reviewer , however, is obliged to confess that he searched diligently through the one hundred and more pages of this book for a fulfillment of these hopes, but without marked success. He may, however, be too hard to please, so we quote a few lines pertaining quite definitely to astronomy and let the reader form his own opinion. On page 30, the meridian is defined as "A thing on which the Astronomer Royal generally sits when on duty at Greenwich. This cancels anything I may have said about it earlier in this chapter." The illustration on page 93, in which by means of a series of reflections an observer looks at the back of his head and concludes that the earth is round, is original and entertaining.

The Relativity Theory Simplified, by Max Talmey. (Falcon Press, 1451 Broadway, New York City. $1.50.)

Because of the wide-spread interest in modern developments in science the above title will prove an intriguing one to many readers. It would be difficult to find an intelligent person who does not feel a desire, it may be largely curiosity, to understand what technically is implied in the much used term *relativity*. The reviewer is one who has read many discussions of this new doctrine. He can say candidly that this volume does what the title claims for it. To be sure even after considerable simplification the ideas still are somewhat elusive. The great difficulty in approaching a new body of thought like this is that one can not divest himself completely of certain preconceptions. He brings with him unintentionally and indeed often unconsciously certain intuitions which tend to obscure the new thought. After one has read, and perhaps reread, this small volume with some care he is sure to have some notion as to the elements of the theory of relativity. The special theory, the general theory, and the unitary field theory are all included.

The author has a warrant for writing this book which only a limited number can lay claim to. He was a boyhood friend of Professor Einstein and for that reason is able to supplement his discussion of the theory with some twenty pages of reminiscence. This gives the book a personal touch which is very pleasing.

The soundness and authoritative character of this volume are attested by a statement by Professor Einstein himself in a letter to the author, as follows:

"Only yesterday I found time to read in your new book. I was glad to see how thoroughly you have occupied yourself with the intellectual basis of the rela-

tivity theory. I do believe your book can bring home the theory to many an intelligent educated layman and to many a student who does not want to penetrate more deeply into the mathematical basis."

Introduction to Practical Astronomy, by Dinsmore Alter. (Thomas Y. Crowell Co., New York. $2.00.)

This book is a collection of 29 laboratory experiments (80 pages plus circular and rectangular coördinate paper) which may be worked out by students with a minimum amount of special astronomical laboratory equipment: circular and rectangular coördinate paper (included in the text), an *American Ephemeris* ($1.75), erasable hemisphere ($4.90), and an engineer's transit being the essential apparatus upon which the majority of the exercises are built. A few exercises need some specialized equipment; for example, verniers and optical benches, while the last four make use of an equatorial telescope. This limited variety of equipment is a good feature, but unless a number of erasable spheres or hemispheres and engineer's transits are available, the number of students in each laboratory section must be small.

The material is conveniently grouped under four headings: Preliminary Experiments, Indoor Experiments, Observations with Engineer's Transit, and the Equatorial Telescope. In brief, the first section, consisting of five exercises, covers a study of verniers, different coördinate systems, lenses, and stars and constellations; the second section of twelve exercises covers a study of time, transformation of coördinates, precession, nutation, aberration, geocentric and heliocentric positions of planets, positions of an inferior planet, eclipses, and regression of lunar nodes; the third section of eight exercises deals with problems in practical astronomy, such as the determination of time by observation of stars on the meridian, of orientation of an observatory from solar observation, etc.; and the last section of four exercises deals with the determination of right ascensions and declinations of objects, and errors of an equatorial telescope.

Most laboratory manuals are built up around the special equipment available in some one college or university. Therefore they are completely useful in their entirety only for this one particular institution. In connection with an elementary descriptive course in astronomy in a small college devoid of a fully equipped observatory, this text is an attempt to produce a laboratory manual that might be generally useful for the laboratory work. For such a purpose, this book places too much emphasis upon experiments leaning towards practical astronomy. A number of very excellent exercises, needing very little or no apparatus, could have been more valuable in a laboratory text supplementing a standard course in descriptive astronomy.

This book is good not only as an elementary study in practical astronomy but also as an introduction to more advanced courses in spherical and practical astronomy. F.L.S.

Publications Received.—The publishers of POPULAR ASTRONOMY hereby acknowledge the receipt of the following named publications and express their great appreciation of the courtesy shown on the part of those who have sent them.

Lund Observatory Circular, No. 7, containing five papers by members of the staff of the Lund Observatory.

Contribution, No. 65, from the Lund Observatory, entitled, Second list of stars with large proper-motions in the A.G. Zone of Lund, by W. Gyllenberg.